Digital scholarship: Exploration of strategies and skills for knowledge creation and dissemination

Cristobal Cobo
Oxford Internet Institute, Oxford University
Oxford, England
cristobal.cobo@oii.ox.ac.uk

Concepcion Naval
Balliol College, Oxford University. Department of Education, University of Navarra
Pamplona, Spain
cnaval@unav.es

***Abstract*— Widespread access to digital technologies has enabled digital scholars to access, create, share, and disseminate academic contents in innovative and diversified ways. Today academic teams in different places can collaborate in virtual environments by conducting scholarly work on the Internet. Two relevant dimensions that have been deeply affected by the emergence of digital scholarship are new facets of knowledge generation (wikis, e-science, online education, distributed R&D, open innovation, open science, peer-based production, online encyclopaedias, user generated content) and new models of knowledge circulation and distribution (e-journals, open repositories, open licenses, academic podcasting initiatives, etc.). This paper provides a review of existing frameworks which have been proposed so far to get a grip on digital scholarship and address the following questions:**

-What strategies are followed by digital scholars to interdisciplinarily (co)create, curate and translate their ideas on the Internet?
- How do digital scholars spread their ideas on the Internet?
- What set of key skills need to be learned (and updated) by scholars who actively create and/or disseminate academic knowledge through the Internet?

Despite the potential transformation of these novel practices and mechanisms of knowledge production and distribution, some authors suggest that digital scholarship can only be of significance if it marks a radical break in scholarship practices brought about through the possibilities enabled in new technologies. This paper address some of the key challenges and raise a set of recommendations to foster the development of key skills, new models of collaboration and cross-disciplinary cooperation between digital scholars.

***Keywords*: digital scholarship; digital research; knowledge based society; education.**

EINS Topics included: Knowledge, education, and scholarship on and through the Web; Internet, society, and innovation; Analysis of human behavior and social interaction using data from social media & online networks; Collective intelligence, collaborative production, and social computing; Intellectual property and the commons

The analysis described in this study will allow us to complete Table 1.

	Mechanisms (tools and technologies)	Digital Scholarship Practices	Key Skills Required
Knowledge Generation	Open Data, Big Data, Wiki-alike, Interoperability for Scholarly Annotation, Zotero	Peer-production, Content curation, cross-disciplinarily	Self-direction, Collaborativeness, critical assessment (crap detection).
Knowledge Distribution	Data visualization, Rubriq, DOAJ, PLOS, PeerJ, open-source platform.	Openness, open/independent peer review, Open License (Green & Golden route)	Creativity, Practice focus, cross platform literacy, knowledge translation, privacy and digital identity awareness.

Keywords*— *digital technologies, digital scholarship, academic knowledge, Internet

1. Current Information Landscape

The exponential growth of information together with the expansion of digital technologies suggests major changes for a world increasingly shaped by the digital revolution. Hilbert and López (2011) indicate that the world's capacity for bidirectional telecommunication is growing at 28% per year, closely followed by the increase in globally stored information (23%). Machines' application-specific capacity to compute information per capita has roughly doubled every 14 months over the past two decades while the global telecommunication capacity per capita doubled every 34 months. These authors state that the world's technological information processing capacities are quickly growing at clearly exponential rates.
The knowledge economy, highly influenced by the unprecedented volume of information, is a new socio-economic order in which new technologies are the drivers of knowledge production and application. Among other producers of knowledge, universities have become a key part

of the innovation system, in which innovation is understood as "the process-of assembling and maintaining a novel alignment of ideas, practices and actors to respond to site-specific issues and/or to pursue a vision" (Häyrinen-Alestalo and Peltola 2006, 253; Tytler et al., 2011; Lecercle 2011). Hurmelinna, Kyläheiko, and Jauhiainen explain that new 'mechanisms of knowledge creation, integration and transfer, play a central role in the evolutionary economics-based dynamic capability' (2007, 142).

The exponential transformation of information is not only remarkable from the quantitative perspective, but also there is a fragmentation and diversification of communication channels and mechanisms to create, access and distribute information. In academic contexts, these phenomena have deeply changed the way in which people work and collaborate.

Two relevant dimensions that have been deeply affected by the emergence of digital scholarship are new facets of **knowledge generation** (wikis, e-science, online education, distributed R&D, open innovation, open science, peer-based production, online encyclopaedias, user generated content) and new models of **knowledge circulation and distribution** (e-journals, open repositories, open licenses, academic podcasting initiative, etc.). The transformations of these two major dimensions are affecting the traditional role of higher education institutions, expressed in new practices and systems.

In connection with the new mechanisms of knowledge production and distribution Benkler (2006) explains that a radical decentralization is shaping the current network society. According to Benkler (p. 32) this radical decentralization of intelligence in our communications networks and the centrality of information, knowledge, culture and ideas to advancing economic activity are 'leading to a new stage of the information economy – the networked information economy'.

In accordance with Burdick, (et al, 2012, p.112-113) this radical decentralization is providing new alternatives for knowledge generation. The creation of a culture of information exchange has the potential to enhance the quality, depth, and reach of digital scholarship. Here the authors remark on the importance of creating common spaces of knowledge production and knowledge exchange (Jankowski, 2009 and Wouters, 2012).

Nowadays an increasing interest in promoting institutional measures to support and facilitate the access and exchange of academic knowledge is observed. For instance, during 2012 two major announcements were made by European Commission (Kroes, 2012) and the Economic and Social Research Council (ESRC) in the UK. In both cases these initiatives aimed to increase, facilitate and accelerate open access to scientific knowledge.

2. DIGITAL SCHOLARSHIP

In the current context, the academic community can harness many more of the diverse pathways and mechanisms for scientific transmission that were muted by the economies of scale that led to the rise of the concentrated, controlled forms of mass media, whether commercial or state-run. One of the most important aspects of the networked information economy is the possibility it opens for reversing the control focus of the industrial information economy. From an institutional perspective this radical decentralization is articulated by new knowledge intensive mechanism and transactions.

Borgman (2007, p. xvii) adds, "Today's initiatives in cyber-infrastructure, e-Science, e-Social Science, e-Humanities, e-Research, and e-Learning emerged from a tumultuous period in scholarly communication in which technological advances converged with economic and institutional restructuring".

Digital scholarship is manifested by new modes of scholarship and institutional units for collaborative, transdisciplinary and computationally engaged research, teaching and publication (Burdick, et al, 2012, p.122). According to these authors, digital scholarship communities collaborate in dynamic, flexible, and open-ended networks for knowledge creation and distribution, which actively exchange innovation, creativity and authoring (idem.p.85) Nonetheless, Pearce et al (2011) emphasis that digital scholarship is more than just using information and communication technologies to research, teach and collaborate; it also embraces the open values, ideology and potential of technologies born of peer-to-peer networking and wiki ways of working in order to benefit both academia and society.

Here four dimensions that play a fundamental role among digital scholarship practices are highlighted:

Technology

The openness and flexibility that different new digital platforms and tools offer (i.e. Google Books, Diigo, Scoop.it, Evernote, Google Drive, Wikipedia, Zotero, etc.) provide multiple opportunities to create new types of knowledge and facilitate the development of novel inter- and multi-disciplinary knowledge.

These platforms become coordination mechanisms that support continuous flows of exchange and codification of tacit knowledge, simplifying its translation into more usable, findable and interchangeable resources (Heimeriks & Vasileiadou, 2008). In this context, digital tools are not just tools. They are cognitive interfaces (coordination mechanism) that presuppose forms of mental and physical discipline and organization (Burdick, et al, 2012, p. 105).

The 'open access' movement in digital scholarship can offer diversified possibilities for stimulating scientific work. Consequently, this openness is not only relevant in terms of providing access to research (i.e. open access journals or databases); but also speeding up scholarly communication and scientific dialog between researchers; facilitating new mechanism of open peer revision (broadly adopted in platforms such as Wikipedia or more scholar-oriented ones such as the Public Library of Science) and offering greater visibility and impact opportunities.

Collaboration - co creation

Rheingold (2012) proposed a comprehensive taxonomy that describes different levels of collaborative work. In this case that categorization can be particularly useful in order to understand different levels of digital collaboration. This classification can be summarized as follow:

- First level (Networking) more simple level of collaboration. It implies low risk and low commitment from the participant's perspective.
- Second Level (Coordination). It requires similar level of commitment than as the one observed in the 'networking' level, but the members identify mutual benefits establishing additional incentives.
- Third level (Cooperation). It implies a more active attitude towards sharing and exchanging. Members identify a common purpose and exists a higher level of trust among participants.
- The fourth level (Collaboration). All participants shared goals. It implies all the previous levels, but in addition participants find mutual benefits, share risks, resources, and rewards.

In previous works (McCarthey & McMahon, 1992; Dutton, 2010 or Cobo, 2012) collaboration is not understood as a one-size-fits-all concept but as a dimension that varies at different levels of negotiation. According to these studies, at least three general hierarchies used in collaboration over the Internet can be identified.

- (level 1) "share" by sharing documents, data and other digital resources, for example using hypertext links.
- (Level 2) encourages "contribution generation" through notes and other content produced by different individuals, and
- (level 3) co-creation, for example, by creating active and distributed knowledge (many-to-many) combining the individual contributions.

One type of interaction is not necessarily better than another; the appropriateness of each depends on the individuals' knowledge of the purpose and the nature of the task. However, the higher the level of collaboration, the more complex the set of skills required to achieve successful negotiation among individuals will be. Bulger, et al. (2011) after exploring different case studies found that that researchers are not moving from less complex information uses to more complex ones, but are broadening their information ecosystems.

Authorship and beta version

Just like in the development of open source, in the context where collaborative writing technologies become increasingly adopted among scholars (Bulger, et al., 2011), the idea of authorship as an autonomous work or as the labour of a solitary genius seems to move toward the harnessing and expressiveness of the creative energies of an ever-expanding, virtually boundless community of digital scholars (Burdick, et al, 2012, p.83). Wuchty (et al., 2007) after analysing almost 20 million papers over 5 decades claim that "teams increasingly dominate solo authors in the production of knowledge. Research is increasingly done in teams across nearly all fields. Teams typically produce more frequently cited research than individuals do".

The collectivization of authorships is also trending toward fluid, iterative, and distributive models. Whatever the medium, authorship is increasingly understood as a collaborative process, with individuals creating materials within the setting of a team that merges their identities into a corporate subject (the laboratory, the technology sandbox, the research group) (Burdick, et al, 2012, p. 110).

Crowd-sourced production mechanism for generating and editing scholarly content (i.e. open peer review journals, social bookmarks, wikis, Google Docs, etc.) are transforming both the authorship function and the use of conventional knowledge platforms. Burdick (et al.) explain that nowadays a book is not simply "finished" and "published," but is now part of a much more dynamic, iterative, and dialogical environment that is predicated on versioning, crowd-sourced models of engagement and peer review, and open source knowledge and publication platforms. Publication is not an endpoint or culmination of research, but is something significantly more process-oriented, indeterminate, experimental, and even experiential (Burdick, et al, 2012, pp. 85 and 89).

Dissemination

Traditionally, publishing meant finding a journal or press in order to make academic treatises, arguments, and the results of research public—but this "public" was in reality primarily or even exclusively readers initiated in and defined by the discursive conventions of a given field (Burdick, et al, 2012, 86). Today, that scenario is changing. After the growth of so-called '2.0' technologies (O'Reilly, 2007), the expansion of open repositories (i.e. Social Science Research Network or Directory of Open Access Journals) and particularly the so-called "new open-access policies" (Van Noorden, 2012) almost anyone can publish (in the sense of "make public") anything.

A re-evaluation of the "publish or perish" syndrome can be found in Jenkins et al. (2010) proclamation "If it doesn't spread, it's dead". Nowadays, the alternatives of publication have diversified significantly. More and more scholars consider the possibility of posting early versions of their academic work on blogs or micro-messages, by posting photographs or videos, hosting a website, commenting on other people's blogs, etc. (Nielsen, 2011).

The participatory environment facilitates the creation of new cultural materials through a growing variety of Do-it-yourself publishing mechanisms (i.e. CreateSpace or Blurb are some examples) that offer new possibilities of "radical decentralization". Here, as Burdick (et al, 2012, p. 96) suggested these new distribution mechanisms will need to evolve in ways that recognize the productive distinction between popular work and more specialized scholarship. In addition, the increasing possibilities of digital knowledge dissemination also raise some challenges such as the

principles of intellectual property, licensing, remixed use of materials or open peer review.

New digital publishing models are challenging the long-standing roles and institutional boundaries (Burdick, et al, 2012, p. 87). The '2.0 tools' provide a new ecosystem of creation and dissemination that complement (even replace, in some cases) the traditional practices of peer-review that have been adopted for centuries to assure the quality of the knowledge (i.e. Public Library of Science). Now an active audience also has the possibility of providing feedback, and can call for amendment or other mechanisms of control or quality (in some cases in real time). As is well-known, Creative Commons provide legal tools and platform to make scientific data and databases freely available. These mechanisms, still under a process of consolidation, are acquiring increasing relevance in the digital scholarship environment (Fitzpatrick, 2009).

The dissemination of digital scholarship can be summarized with the 4'R: reuse, revise, remix and redistribute. Wiley (2010) explains that the primary permissions or usage rights for open content are expressed by: *reuse* (the right to reuse the content in its unaltered/verbatim form); *revise* (the right to adapt, adjust, modify or alter the content itself); *remix* (the right to combine the original or revised content with other content to create something new); and *redistribute* (the right to share copies of the original content, your revisions or your remixes with others).

Is the scholar community willing to change their working practices?

Taking into account these novel mechanisms and practice of knowledge generation and distribution, Burdick, et al. (2012, p. 112) enquire: Will our universities and colleges institutionalize approaches to learning and research grounded in collaboration and cooperation instead of celebrity and competition? Or will we continue to allow profit-driven entities to shape the networked environment on which our digital future depends?

In order to address this question, Chesbrough suggest that we live in a new paradigm of knowledge exchange called open innovation, which occurs when organisations and individuals share risks and rewards extensively. This paradigm holds that a field of knowledge must be used readily if it is to provide value to the organisation that creates it. Nevertheless, this author suggest that resistance to change occurs, he suggest that this transition implies potential confrontations when '[t]he shift in knowledge landscape is disturbing to people familiar with the earlier paradigm' (2006, 41). Sohail and Daud noted that 'knowledge sharing is inevitably challenging and an important concept in higher learning institutions' (2009, p.129), and Seonghee and Boryung (2008, p.282) argued that the members of academic organisations often resist knowledge sharing:

> [I]ndividual members of academic institutions place a higher priority on individual scholarly achievement […]. Consequently, there is a relatively weak willingness to share knowledge for achieving common goals in academia compared to in profit-oriented organizations. Due to these unique characteristics of exclusiveness and individualism, knowledge-sharing and knowledge management in academic organizations are often not systematic and may be inefficient.

Menkhoff, Evers, and Wah (2010, 230) noted that while universities have traditionally been viewed as archetypal learning communities, 'where there is substantial knowledge sharing in term of academic knowledge and expertise in the form of journal publication and teaching, these forms of knowledge sharing are paradoxically induced more by peer-competition than altruistic sharing'. Kanwar, Kodhandaraman, and Umar (2010, 73) add that the lack of partnership in a highly competitive environment can also affect the development of open educational or open science initiatives. Researchers and scientists are living in a continue competition ranging from contest for academic positions, research grants, or in order to bringing their academic institution to the top of international rankings. Either for concern of professional development or the risk of being left behind ('stick or the carrot') the academic mechanisms of recognition in many cases are limited to metrics such as the 'h-index' a single-number criterion to evaluate the scientific output of a researcher (Hirsch, 2005). This permanent competition for professional development does not always provide the more appropriate framework to facilitate peers based collaboration. Adler and Harzing (2009) claim that current academic assessment systems reward scholarship are dysfunctional and potentially cause more harm than good.

On the other hand, Kenway, Bullen & Robb (2004, p. 338) emphasize that 'there is considerable pressure on all academics to become particular sorts of networkers'. They stress the importance of exchanging information across disciplinary or institutional borders and spreading knowledge and excellence that foster new connections and relationships.

At this stage is not easy to determine how and to what extent the traditional and the new practices (here described as digital) of scholarship will coexist. Is expected that the scholars' practices might evolve when there is the appropriate institutional recognition (i.e. a tenure evaluation system that recognizes the value of new publication formats but also more flexible mechanisms of knowledge dissemination). A tradeoff between a digital ecosystem that offers unlimited channels of knowledge dissemination and the idea of exclusive excellence where the academic systems encourage publishing only at locations that have the highest impact factor and the best indexing ('h-index'). This mismatch illustrates part of the current digital scholar landscape.

Flanders (2009) states that digital tools are not neutral and remarks a whole new range of challenges (i.e representation, medium, and structures). The author summarizes some of the tensions in this field: digital scholarship is uneasy about the significance of medium; digital scholarship is uneasy about the institutional structures of scholarly communication; and

digital scholarship is uneasy about the significance of representation in forming models of the world.

Additional drawbacks identified in the digital scholarship spectrum are: **dependence on technology** (i.e. 'if it's not on the web, it doesn't exist at all', technological progressivism, broadband divide generating inclusion and exclusion); **tenure evaluation systems** (i.e. current metrics to assess academic value dismiss the new, potentially better digital scholar practices); **information overload** (i.e. intoxication, infobesity, information anxiety); **increasing complexity** (i.e. open dissemination strategies demand increasing awareness, tech savviness, and additional funding in cases like the golden route publication); **publish or perish** (pressure in academia to rapidly and continuously publish academic work in high impact journal, in many cases non-open-access publication); **interdisciplinary boundaries** (i.e. a cross disciplinary science need to overcome divisions between methods, tools, expertise, jargon, etc.)

3. KEY SKILLS FOR DIGITAL SCHOLARSHIP

Taking into account the trends and practices of digital scholarship described, how do digital researchers learn and update their knowledge and skills? What are the key skills for academic knowledge creation and dissemination? Where and how can these skills be learned?

The landscape described suggests that one of the central problems in the development of digital scholarship is not the technology per se, nor the role of the user in technological environments, but the cultural and historical specificity of knowledge (Wouters, 2004, p.3). Pearce et al. (2011) acknowledge that the adoption of digital tools cannot be understood or oversimplified as an inevitable change in scholars practices which have remained relatively stable along the years (or if they have changed it has been due to much greater forces, such as the move from elite to mass participation, introduction of fees or economic incentives, etc.).

In order to facilitate the creation of novel disciplinary boundaries which are more permeable to new scholarly practices a whole set of cultural practices will be required: institutional flexibility (i.e. diversifying tenure track, re-understanding concepts such as academic visibility or digital influence) as well as development of the appropriate skills for knowledge production in the new technologically mediated contexts.

From the individual scholar's point of view appropriating (or re-appropriating) these tools requires a new set of skills that lie outside the traditional knowledge-based research practices. Burdick, et al. (2012) suggest that the outside skills—skills in fields such as design, computer science, media practice, curation, or library science—are assuming increasing importance alongside core training in digital scholarship (particularly in humanities). No longer trained for academic careers alone, skilled in practical as well as theoretical domains, they (scholars) are moving more fluidly between institutions of memory, industry, and academia (p. 117). These authors recommend four competences, which are particularly central to contemporary scholar activity: **curation, analysis, editing, and modelling**.

These authors understand these proficiencies as part of an "open source culture" which includes work practices such as: collaborative authoring, multiple versioning, flexible attitudes toward intellectual property, peer contributions, access to multiple and multiplying communities, and overall patterns of distributed knowledge production, review, and use (Burdick, et al, 2012, p. 77).

The reason for suggesting these competencies as "outside" dexterities is attributable the fact that these are not necessarily associated with traditional academic training such as statistical analysis programming and data-mining. These 'outside' skills should be understood as an extension of traditional knowledge skills and methods, not a replacement for them. It will demand that the new generation of digital scholars model new ways of exploiting the digital domain, and look for innovative ways of public engagement and distributed collaboration, as well as novel publishing models.

Some of the abilities and knowledge required to foster this networked scholarship in this digital ecosystem could vary significantly depending on the stakeholder or context. However, it seems important to identify and develop a set of relevant skills to work across this ecosystem where the information intermediaries are notably more diverse than in the last decades.

The Institute for the Future foresees 10 skills considered vital for the workforce in the coming years (2020). The study classified the key proficiencies and abilities required across different jobs and work settings. It is noteworthy that, the skills and expertise described in this study provide a comprehensive 'picture' to better understand (and study) the competence for digital scholarship (Davies, Fidler, and Gorbis, 2011).

- **Sense-making**: the ability to determine the deeper meaning or significance of what is being expressed.
- **Social intelligence**: the ability to connect to others in a deep and direct way, and to sense and stimulate reactions and desired interactions.
- **Novel and adaptive thinking**: proficiency at thinking and coming up with solutions and responses beyond those that are rule-based.
- **Cross-cultural competency:** the ability to operate in different cultural settings in a truly globally connected world.
- **Computational thinking:** the ability to translate vast amounts of data into abstract concepts and to understand data-based reasoning.

- **New Media Literacy:** the ability to critically assess and develop content that uses new media forms, and to leverage these media for persuasive communication.

- **Transdisciplinarity:** literacy in and ability to understand concepts across multiple disciplines.

- **Design mindset:** the ability to represent and develop tasks and work processes for desired outcomes.

- **Cognitive load management:** the ability to discriminate and filter information in terms of importance, and to understand how to maximize cognitive functioning using a variety of tools and techniques.

- **Virtual collaboration:** the ability to work productively, drive engagement, and demonstrate presence as a member of a virtual team.

Borgman (2007) suggests that information literacy and particularly critical thinking skills are an essential part of becoming educated, however these are not skills that are easily taught. The skills described here acknowledge the importance of the informal development of this set of abilities.

The European Centre for the Development of Vocational Training states that *informal learning* results from daily activities related to work, family or leisure. It is not organised or structured in terms of objectives, time or learning support. Informal learning is in most cases unintentional from the learner's perspective (Tissot, 2008).

In this case, it is hypothesized that researchers develop a number of key skills for digital scholarship (particularly in term of novel forms of knowledge creation and dissemination) based on specific, individual or collective needs, without formal instructors or official recognition, that lead them to develop new tacit and explicit theoretical and/or empirical knowledge relevant to work on science in the 21st century.

4. Recommendations and Remarks for future research

- Facilitate the creation of spaces and opportunities, either formal or informal (i.e. re-skilling programmes, mobility initiatives, workshops or summer schools) that stimulate the development of skills for digital scholarship by fostering the combination of different learning styles as well as more diverse formal, non-formal and informal educational environments.

- The integration of disciplines (i.e. cross disciplines, inter-, intra-, trans-, multidiscipline) must be facilitated and consistently promoted. In order to do so, there must be instance and context (i.e. complex problems) which stimulate redefining the boundaries of the humanities, the social sciences, the arts, and the natural sciences in order to study the imminent generation of an Internet Science.

- Development of opportunities to make the most of the digital platforms (i.e. peer based training) allowing exploration and exchange of novel and combined research methods.

- To stimulate and reward the adoption of distributed and collective practices that facilitates the creation and adoption of flexible data sharing practice (i.e. free and open data initiatives).

- To create new metrics assessing how well individual scholars and universities are doing in terms of knowledge dissemination and research impact. Evaluation mechanisms that are not entrapped in simple and reductionist approaches (i.e. metrics based on counting publications or citations).

- To promote the implementation of formal and informal up skilling opportunities, especially in international work environments encouraging researchers to acquire competences for digital scholarship.

- Development of strategies and programmes to increase digital awareness and literacy in order to better understand subjects such as: digital identity (i.e. digital footprint), privacy awareness (i.e. right to delete), more flexible licensing premises (i.e. Creative Commons Science; open journals or open data, etc.), or open-source culture (i.e. collaborative authoring or multiple versioning).

- To consider the importance of bringing open access and new publication formats into the tenure evaluation system. Doing this could not only contribute to the tenure process, but may also serve to promote open access and more efficient knowledge dissemination. Notably, the required mechanisms and technology to promote the change are already available, but cultural and institutional constraints make this transition to opening particularly slow.

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