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If you build it, will they come?

How researchers perceive and use web 2.0

A Research Information Network report

July 2010



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Contents

Executive summary	4	4. Contours of adoption	18	6. Conclusions: the dynamics of adoption and use	46
1. Introduction	10	4.1 Use of web 2.0 tools associated with producing, commenting on, and sharing scholarly content	19	7. Implications for universities, funders and researchers	50
2. Web 2.0 and scholarly communications	12	4.2 Dissemination choices	27	7.1 Implications for university computing and information services	52
3. Methodology	16	4.3 Open science?	30	7.2 Implications for universities and funders	52
		4.4 Social networking	32	7.3 Implications for researchers	53
		4.5 Information-seeking	34	References	54
		4.6 Peer review and quality assurance	36	Annex: Data tables	57
		5. Case studies of web 2.0 for scholarly communications	38		
		5.1 Innovation and the role of users in creating web 2.0 services	43		
		5.2 Managing uncertainty and developing future prospects	44		

Executive summary

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Executive summary

Over the past 15 years, the web has transformed the way we seek and use information. In the last 5 years in particular a set of innovative techniques – collectively termed ‘web 2.0’ – have enabled people to become producers as well as consumers of information.

It has been suggested that these relatively easy-to-use tools, and the behaviours which underpin their use, have enormous potential for scholarly researchers, enabling them to communicate their research and its findings more rapidly, broadly and effectively than ever before.

This report is based on a study commissioned by the Research Information Network to investigate whether such aspirations are being realised. It seeks to improve our currently limited understanding of whether, and if so how, researchers are making use of various web 2.0 tools in the course of their work, the factors that encourage or inhibit adoption, and researchers’ attitudes towards web 2.0 and other forms of communication.

Context

How researchers communicate their work and their findings varies in different subjects or disciplines, and in different institutional settings. Such differences have a strong influence on how researchers approach the adoption – or not – of new information and communications technologies. It is also important to stress that ‘web 2.0’ encompasses a wide range of interactions between technologies and social practices which allow web users to generate, repurpose and share content with each other. We focus in this study on a range of generic tools – wikis, blogs and some social networking systems – as well as those designed specifically by and for people within the scholarly community.

Method

Our study was designed not only to capture current attitudes and patterns of adoption but also to identify researchers’ needs and aspirations, and problems that they encounter.

We began with an online survey, which collected information about researchers’ information gathering and dissemination habits and their attitudes towards web 2.0. This was followed by in-depth, semi-structured interviews with a stratified sample of survey respondents to explore in more depth their experience of web 2.0, including perceived barriers as well as drivers to adoption. Finally, we undertook five case studies of web 2.0 services to investigate their development and adoption across different communities and business models.

Key findings

Our study indicates that a majority of researchers are making at least occasional use of one or more web 2.0 tools or services for purposes related to their research: for communicating their work; for developing and sustaining networks and collaborations; or for finding out about what others are doing. But frequent or intensive use is rare, and some researchers regard blogs, wikis and other novel forms of communication as a waste of time or even dangerous.

In deciding if they will make web 2.0 tools and services part of their everyday practice, the key questions for researchers are the benefits they may secure from doing so, and how it fits with their use of established services. Researchers who use web 2.0 tools and services do not see them as comparable to or substitutes for other channels and means of communication, but as having their own distinctive role for specific purposes and at particular stages of research. And frequent use of one kind of tool does not imply frequent use of others as well.

When deciding when, where and how to publish their work, researchers place the highest value on well-established channels of communication including scholarly journals, conference proceedings and monographs. They do so because such channels are the pre-eminent means by which they gain recognition from their peers, and secure the career rewards that flow from such recognition.

Researchers are broadly supportive in their attitudes towards web 2.0: even non-users are more likely to define themselves as enthusiastic than as sceptical or uninterested. But while there are some variations between disciplines, web 2.0 tools are for the most part not considered to be particularly important. This is unlikely to change until significant numbers of researchers see clear benefits from the use of web 2.0.

There has been considerable interest in the last two-three years in concepts of open science or open research; and in finding ways to put into effect the proposition that all kinds of information and other resources produced by researchers should flow as public goods into an open infrastructure that supports and facilitates reconfiguration and integration of those resources. Our findings show that very few researchers are as yet operating in this way. About half of respondents to our survey share their work with colleagues, but only a small group of enthusiastic open researchers – 5% of our respondents – publish their outputs and their work in progress openly, using blogs and other tools. Others consider such practices a waste of time, or even that it risks bringing ‘anarchy in science’.

Researchers communicate for many purposes other than sharing their results, and our research found that 13% of respondents frequently – at least once a week – use social networking services for purposes related to their work. The majority of these are occasional, rather than frequent, users of those web 2.0 tools and services for communicating scholarly content that we have discussed above. Their demographic profile is also different, with more junior and younger researchers more likely to be frequent users of social networking. A small subset of researchers is using blogs enthusiastically in order to engage with their colleagues, raise their profiles and extend their networks. And we found broad support for the use of social networking tools to widen collaborations. There are also signs that some researchers – frequent users of web 2.0 services in particular – are using them to learn about research communities beyond their personal networks, or to help them filter the deluge of information with which they are often faced.

Executive summary

Benefits and incentives

Widespread adoption of web 2.0 services by researchers depends on their being intuitive and easy to use, and incremental in building on existing practices. Above all, they must offer clear advantages to users, and near zero adoption costs. Beyond these, there are two key incentives: first, the need for intense communication with colleagues that may arise in running collaborative projects and networks across institutional boundaries; and second, support from local colleagues in identifying relevant tools, in demonstrating their utility, and in reducing learning and start-up costs and other barriers to adoption.

Those who promote the use of web 2.0 by researchers point to the benefits that can come from relatively unconstrained and rapid dissemination and discussion of ideas and findings. And we found researchers who spoke of how using web 2.0 tools and services has increased their profile and awareness of their work among people who might otherwise not have heard of it. Many also pointed to how web 2.0 facilitates and promotes collaborations across the globe. There are clear correlations between use of web 2.0 tools and services and researchers' involvement in collaborative work across institutional and national boundaries.

Other researchers value the informality of communicating in these relatively new ways, and appreciate the scope for comments and interactions before the results of research are published formally. Some point to how active use of web 2.0 may bring a perception of operating at the cutting edge, with the benefits that flow from that.

Barriers and constraints

The major barrier to take-up of web 2.0 tools and services is lack of clarity – even among some frequent users – as to what the benefits might be. The costs of adoption are not always trivial, and unless researchers receive active support and see clear and quick benefits, they tend to keep to the tools and services that they know and trust. Moreover, the rapid development and proliferation of web 2.0 services mean that it is hard to keep track of them, or assess their potential benefits. These problems are exacerbated by the fragmentation of the user-base: few services have yet achieved the critical mass needed to achieve the positive network effects that stimulate pervasive use by particular communities. Researchers may well be right to defer a decision to take up a particular service until they are sure that large numbers of their colleagues have done so.

But a second major set of barriers revolve around perceptions of quality and trust. Both as producers and consumers of information, researchers seek assurances of quality; and many of them are discouraged from making use of new forms of scholarly communications because they do not trust what has not been subject to formal peer review. A significant minority of researchers believe that peer review in its current forms will become increasingly unsustainable over the next five years, and nearly half (47%) expect that it will be complemented by citation and usage statistics, and user ratings and comments. But at present they do not see such measures as an adequate substitute for peer review. Trust is also a concern for researchers who are producing, rather than consuming, information; they are cautious about sharing results and findings in a medium which, as yet, has no standardised way to formally attribute authorship.

Overall, there is little evidence at present to suggest that web 2.0 will prompt in the short

It seems most likely, therefore, that web 2.0 services will continue to evolve as supplements

We are still at an early stage in the development of web 2.0 tools and services, and the

- encourage open-ended experimentation, and avoid the risk of stifling innovation by

Executive summary

We recommend in particular that:

University computing and information services should:

- raise awareness of tools and services, and the uses to which they can be put;
- publicise examples of successful use and good practice;
- provide guidance and training;
- help set standards for curation and preservation.

Universities and funders should:

- develop policy frameworks to encourage a balance between innovation and openness on the one hand, and integrity and security on the other, taking account of issues including:
 - knowledge transfer and socio-economic impact;
 - confidentiality, security and intellectual property rights;
 - assessment, recognition and reward systems;
 - training and staff development;
 - the diverse needs and practices of researchers in different disciplines and communities;
 - data curation and sharing.

Researchers should:

- consider the full range of available tools and services available to support their research and scholarly communications;
- share good practice and learn from each other in use of web 2.0 tools.

1. Introduction

The background of the slide features a warm, orange-to-yellow gradient. Overlaid on this is a grid of thin, light-colored lines. Large, semi-transparent binary digits (0s and 1s) are scattered across the grid, creating a digital or data-themed aesthetic. The text '1. Introduction' is positioned in the upper left area, with a dotted line extending horizontally from its base.

Introduction

Over the past 15 years, the web has transformed the ways in which we seek and use information. The past five years have seen a new array of innovations that go collectively under the name of ‘web 2.0’. That term was coined to point to the emergence and rapid uptake of a group of new information tools and services – such as social networking sites – that are easy to use, and which enable their users to be producers and publishers rather than just consumers of information (*O’Reilly, 2005; Anderson, 2007*). Such services could enable researchers to create, annotate, review, reuse and represent information in new ways. This could promote innovations in how researchers communicate their work and findings that might help realise the e-research vision of improved productivity and reduced ‘time to discovery’ (*Arms and Larsen, 2007; Hey, Tansley and Tolle, 2009; Hannay, 2009*).

Despite an increasing interest in web 2.0 as a platform and enabler for e-research, we have limited understanding of the factors influencing adoption, of how web 2.0 tools and services are being used, or of the implications for researchers, their research practices, and the policies of research funders and institutions.

This report presents the findings of research sponsored by the Research Information Network.¹ The aims of the study were to investigate the extent of adoption of various web 2.0 tools in different subject fields and disciplines, and the demographic characteristics of the researchers who use them. It also sought to examine the factors that influence researchers to use web 2.0 tools, and conversely the factors that prevent, constrain or discourage usage.

Finally, the study sought to explore whether, and if so how, web 2.0 tools are changing researchers’ behaviour in significant ways.

We begin by summarising the extent of adoption and the demographic characteristics of users and non-users. We then examine factors that seem to influence researchers’ adoption decisions and the evidence for change in scholarly communication practices. Finally, case studies of selected examples of web 2.0 services provide insights into innovation processes in developing and promoting web 2.0 services. We conclude by considering the implications of our findings for the policies and practices of researchers, higher education institutions, and funders.

Despite an increasing interest in web 2.0 as a platform and enabler for e-research, we have limited understanding of the factors influencing adoption.

¹ www.rin.ac.uk

2. Web 2.0 and scholarly communications

Web 2.0 and scholarly communications

The term scholarly communications is often considered to refer primarily to the process of publishing peer-reviewed research. We take a broader view, building on Thorin (2003), and we treat scholarly communications as covering all the activities involved in:

- conducting research, developing ideas and informal communications;
- preparing, shaping and communicating what will become formal research outputs;
- disseminating formal outputs;
- managing personal careers, and research teams and programmes;
- communicating scholarly ideas to broader communities.

Each of these activities draws on a rich set of organisational and cultural practices and histories, involving a changing set of information resources, communication methods, and technologies.

The literature on the sociology of science and scholarly communications shows huge variations in practices between researchers in different domains and disciplines. Moreover, particular sub-disciplines and schools of analysis, and emerging interdisciplinary areas, may have cultures very different from their 'parent' fields (Knorr

Cetina, 1999). These disciplinary and local cultures have a strong influence on how new information and communications technologies (ICTs) are adopted (Star, 1995; Stephen and Harrison, 2002; Harley et al., 2008; Fry, 2004; Sparks, 2005; Arms and Larsen, 2007; Borgman, 2007). While new ICTs have led to new forms of publishing, the central position of traditional journals and monographs in scientific discourse, and in building reputations and careers, means they remain the core currency (Arms and Larsen, 2007; Harley et al., 2008; Research Information Network, 2009; Harley et al., 2010).

The transition over the past decade to digital publishing and making scholarly journals available online has been accompanied by the emergence of new ideas about the practice of scholarly communications, and the development of the open access movement.² As open access publishing has become more widespread, even more radical ideas for the 'opening' of scholarly communication are being proposed. One is the notion of 'open science' (Neylon and Wu, 2009) with its advocacy of more open systems and processes for producing and publishing scientific knowledge (Hull, Pettifer and Kell 2008; Murray-Rust 2008), inspired by discourses developed in 'Free/Open Source Software' and 'Creative Commons' movements (Lessig, 2004; Benkler and Nissenbaum, 2006; Elliott and Scacchi, 2008). Web 2.0 is widely seen as providing a technical platform essential to this 're-evolution' of science (Waldrop, 2008; De Roure, 2008).

² 'The Internet has fundamentally changed the practical and economic realities of distributing scientific knowledge and cultural heritage. For the first time ever, the Internet now offers the chance to constitute a global and interactive representation of human knowledge, including cultural heritage and the guarantee of worldwide access.' Preface to Berlin Declaration on *Open Access to Knowledge in the Sciences and Humanities*, 22 Oct 2003, Berlin, Max-Planck-Portal <http://oa.mpg.de/openaccess-berlin/berlindeclaration.html> [Accessed 7 June 2010]

‘Web 2.0 encompasses a variety of different meanings that include an increased emphasis on user-generated content, data and content sharing and collaborative effort, together with the use of various kinds of social software, new ways of interacting with web-based applications, and the use of the web as a platform for generating, re-purposing and consuming content.’

Web 2.0 is thus not just about the configuration of technologies, but also about changing practices in communicating and producing information. Web 2.0 services emphasise decentralised and collective generation, assessment and organisation of information, often with new forms of technological intermediation (*Surowieki, 2004*). Web 2.0 is thus relevant to a large range of scholarly communication practices, from publishing and promoting papers to sharing of digital research artefacts and co-ordinating collaborative work.

The relative openness and visibility of established scholarly networks, compared to those of business or private individuals, may make it look as if other communities are using web 2.0 to play catch-up. Thus some web 2.0 services appear to be updated versions of co-operative tools already widely used in research, such as email lists and newsgroups. Web 2.0 services can, however, provide much more systematic and scalable replacements for many current ad hoc information sharing practices.

- ownership and control of research outputs by individuals, institutions and publishers;
- institutional, individual and cultural factors shaping collaboration;
- the quality and provenance of information;
- institutional and technical solutions and resolutions of issues of standardisation, IPR and security.

Web 2.0 and scholarly communications

These factors can manifest themselves as barriers or as drivers. For example, a commonly identified barrier is that web 2.0-based modes of scholarly communication may not be recognised by existing systems for quality assurance and evaluation, which revolve around peer-reviewed publication. On the other hand, a possibly crucial driver is the potential of web 2.0 to facilitate new and more effective forms of research collaboration, to improve research productivity, and to enhance knowledge transfer, both between different disciplinary communities and with external stakeholders. The collaborative potential of web 2.0 techniques is due in part to its flexibility and capacity for rapid information sharing, which is itself a product of the fact that (unlike traditional scholarly publication methods) it is not slowed down by processes such as peer review, which researchers value so highly.

By focusing on the factors that shape the use of web 2.0, we are highlighting how the scholarly community is shaping the technologies and practices it employs to create knowledge, and to sustain itself (*Williams and Edge, 1996*). The process of research depends on the continual development of tools, services, institutions and practices to enable that research, from scientific instruments to the British Library. Innovation may be driven top-down, with design, standardisation and implementation being steered from outside the user community, then imposed by senior decision makers; or it may follow from local experimentation to meet specific local needs, with researchers creating new tools themselves, or adopting and adapting those created by others. In that bottom-up mode of innovation, established structures will not be overturned, but novel and complementary practices can

flourish. The internet itself is in large part the creation of researchers seeking new forms of communication (*Castells, 2001*).

This study shows UK researchers and others largely following the second mode of innovation. New tools and services are being created by a range of players: researchers themselves, publishers, IT specialists, libraries and information services, and entrepreneurs from outside the traditional world of scholarly communication. While many researchers may be discouraged from participating for reasons given above, others welcome the freedom to innovate within their specific sphere and professional relationships. Recent research in the US shows innovation in the use of web 2.0 coming from partnerships of senior staff free from the pressures career building, alongside younger researchers and graduate students (*Harley et al., 2008*).

This report seeks to characterise the state of innovation and use of web 2.0 in UK scholarly practice, and to identify how and why some scholars are turning to web 2.0. It also enables us to examine which aspects of web 2.0 may sustain established practices and institutions in scholarly communications, and where innovation might lead to systemic change.

3. Methodology

The background of the slide is a dark green color with a white grid pattern. A wavy, glowing green line curves across the lower half of the slide. A horizontal dotted line is positioned below the section header.

Methodology

Our study deployed a composite methodology designed not only to capture current attitudes and patterns of adoption but also to identify problems and the needs and aspirations of researchers.

First, we used an on-line survey to gather basic demographic data (age, gender, position and discipline), to document respondents' dissemination practices, and to measure the extent of their research collaborations, uses of web 2.0 resources, and attitudes towards new technology. Researchers were not asked specifically about their use of 'web 2.0' since many are unfamiliar with the concept. Instead, they were asked about their existing scholarly communications practices, as well as their attitudes towards and use of more novel techniques and services. The survey results were cross-tabulated and subjected to appropriate statistical tests (chi-squared for non-ordinal variables, Cochran-Armitage Trend Test for combinations of non-ordinal and ordinal variables, and Spearman Rank Correlation for ordinal variables).

The sampling frame for the survey was a list of 12,000 email addresses harvested from websites in the ac.uk domain and then cleaned to remove duplicates and irrelevant addresses. 1308 valid responses were received, a response rate of 10.9%. The respondents represent approximately 0.8% of full-time UK academics and postgraduates; and the sample is reasonably representative when compared with key demographic characteristics of the overall UK academic population as recorded by the Higher Education Statistics Agency.³

PhD candidates account for 27% of the sample and all disciplines are represented; but there is a bias towards social sciences and economics.

Second, we conducted in-depth, semi-structured interviews (face-to-face and by telephone) with a stratified sample of 56 survey respondents in order to explore the uses they were making of web 2.0, their experiences, and their perceptions of barriers and drivers to adoption.

Third, we conducted a series of case studies of web 2.0-based services, including a total of fifteen semi-structured interviews with service developers and twenty interviews with users to investigate adoption issues in more depth within particular user communities. The five case studies were:

- Nature Publishing Group (NPG), an academic publishing subsidiary of Macmillan;
- Public Library of Science (PLOS), a US-based open access publisher in the bio-medical field;
- SlideShare, a commercial start-up providing advertising-funded hosting of presentations;
- myExperiment, a web-based Virtual Research Environment (VRE) for curating and sharing digital research resources;
- arts-humanities.net, a 'hub' for teaching and research in the digital humanities.

These case studies were chosen to illustrate how commercial and not-for-profit publishers are developing their services in a web 2.0 world; how researchers are using or might use a commercial tool; and the development and use of researcher-generated tools and services.

³ Data sourced from the Higher Education Statistics Agency.
The latest available data is for 2007-2008. See [http:// www.hesa.ac.uk](http://www.hesa.ac.uk)

4. Contours of adoption

Contours of adoption

The survey results indicate that most researchers use well-known generic tools such as Google Scholar (73%) and Wikipedia (69%). They also indicate that a significant minority of researchers also use other well-known social networking services such as YouTube (29%), Facebook (24%) and Twitter (10%). Overall, however, the survey indicates that use by the UK research community of web 2.0-based services for novel forms of scholarly communication is relatively low.

4.1 Use of web 2.0 tools associated with producing, commenting on, and sharing scholarly content

As a baseline for our analysis, respondents were asked about their use of specific kinds of web 2.0 tools and services that are closely associated with producing, commenting on, and sharing scholarly content. On the basis of 1,282 valid responses, we identified (as shown in Table A) three distinct groups among our respondents reflecting different degrees of adoption of web 2.0 tools for scholarly communications purposes: writing blogs, adding comments to others' blogs or to online journal articles, contributing to a wiki, and posting slide presentations and other kinds of content on publicly-available services.

The three groups thus comprise:

- frequent users (13%; 175 people): a small group who do one or more of the activities listed in Table A at least weekly;
- occasional users (45%; 589 people): a larger group who do one or more of the activities listed in Table A occasionally; and
- non-users (39%; 518 people): another large group who never do any of the activities listed in Table A.

These results indicate that while use at least occasionally of web 2.0 tools and services of the kind listed in Table A is reasonably widespread across the UK research community, frequent or intensive use is relatively rare.

The use of web 2.0 in scholarly communications is often characterised as being of special interest for a younger, Facebook, generation, but our results suggest that the influence of age and position is more complex, and that the differences are not nearly so marked as some have assumed. Figures 1-4 summarise the contours of the activities and use of the tools listed in Table A by age, position, discipline and sex.

	Never		Occasionally		Frequently		BASE
	Count	%	Count	%	Count	%	
Write a blog	1087	84%	155	12%	51	4%	1293
Comment on other peoples' blogs	978	77%	273	21%	28	2%	1279
Contribute to a private wiki	1066	81%	191	15%	58	4%	1315
Contribute to a public wiki (e.g. Wikipedia)	1072	82%	215	17%	15	1%	1302
Add comments to online journal articles	1023	78%	267	20%	16	1%	1306
Post slides, text, videos etc. publicly	820	64%	382	30%	80	6%	1282

Contours of adoption

Figure 2:
frequency of use by position

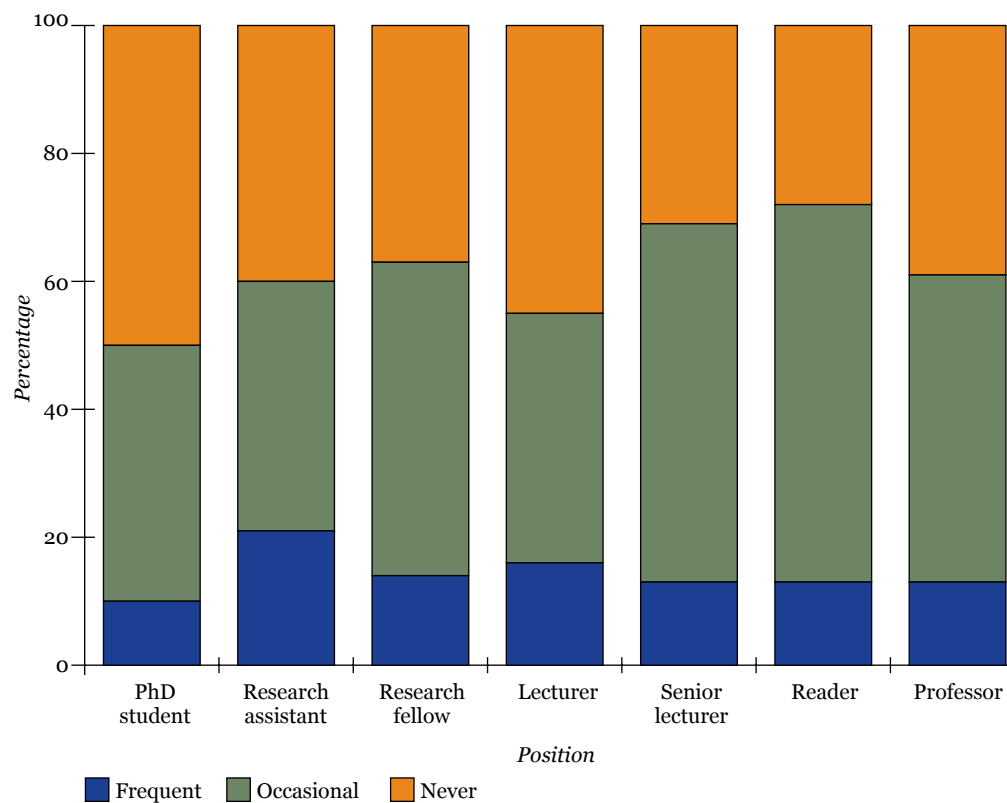
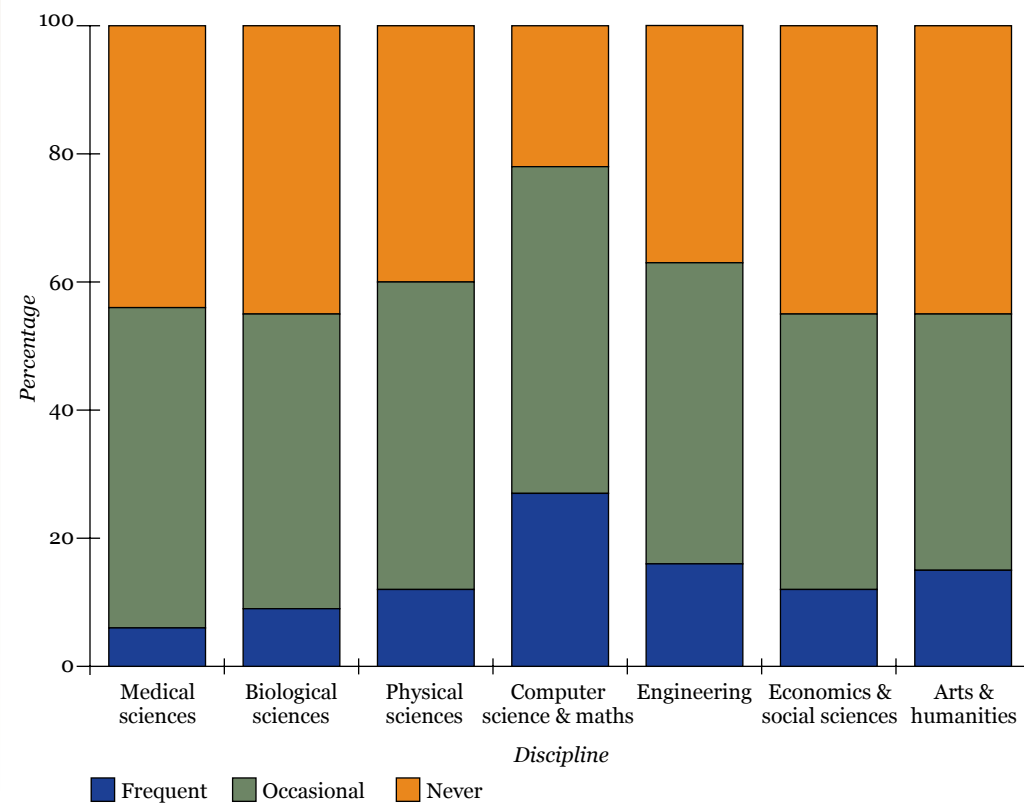


Figure 3:
Frequency of use by discipline



There are also discipline effects. As Figure 3 shows, respondents in computer science and mathematics are disproportionately represented among frequent users; while researchers in the medical and life sciences are relatively under-represented, along with those in social sciences, arts and humanities. It is worth noting, however, that within the figures represented here, some groups make particular use of specific tools. Thus arts and humanities researchers, with relatively few frequent users overall, feature much more prominently among frequent bloggers (Table 12, Annex). It should also be stressed that we have not undertaken a multivariate analysis, and so we cannot make any judgements about the relative importance of each demographic factor. Moreover, it seems likely that relationships between variables, such as age and position, may underpin some of the observed correlations. The varying gender profiles of different disciplinary groups may also underpin some of the observed differences between men and women shown in Figure 4.

A stacked bar chart titled 'Percentage' on the y-axis and 'Sex' on the x-axis. The y-axis ranges from 0 to 100 in increments of 20. The x-axis has two categories: 'Female' and 'Male'. Each bar is divided into three segments: 'Frequent' (blue, bottom), 'Occasional' (green, middle), and 'Never' (orange, top). For females, the segments are approximately 10% frequent, 42% occasional, and 48% never. For males, the segments are approximately 16% frequent, 49% occasional, and 35% never.

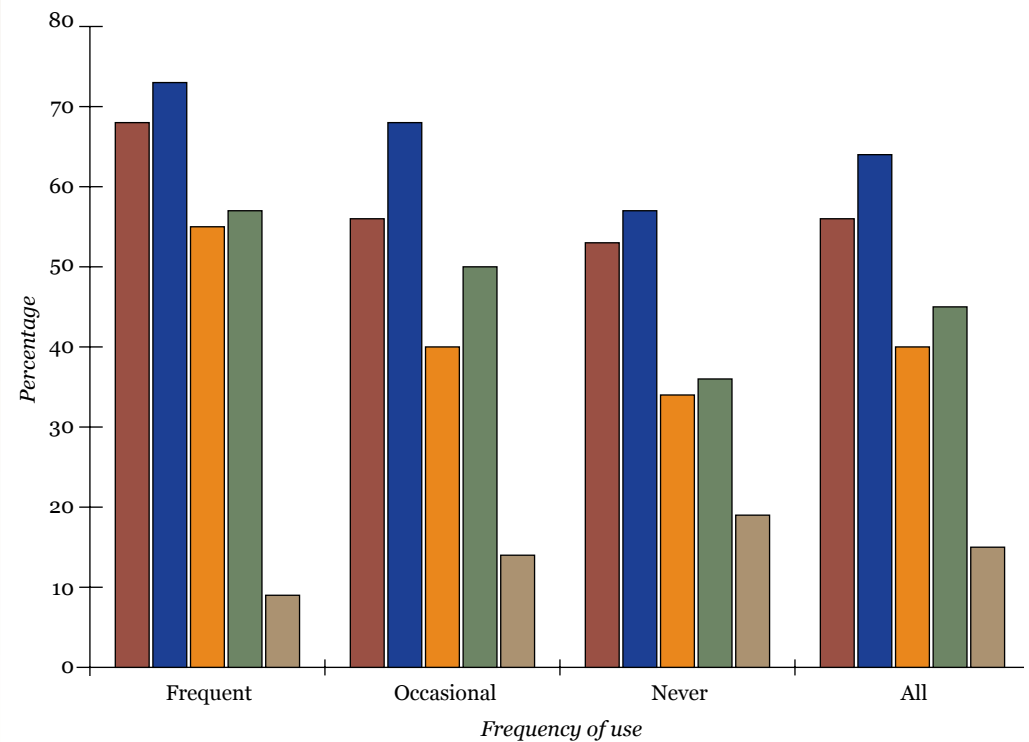
Sex	Frequent	Occasional	Never
Female	10	42	48
Male	16	49	35

Contours of adoption

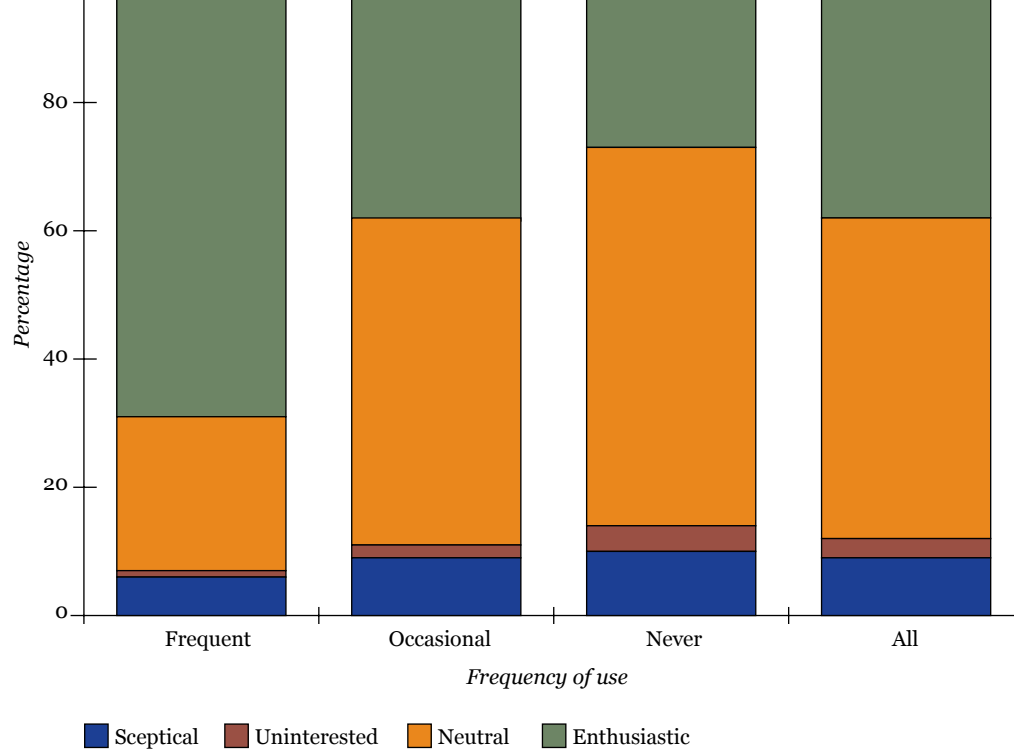
Our survey results also suggest that use is positively influenced by researchers' involvement in collaborative research activities. As Figure 5 shows, those who work in collaboration with different institutions are significantly more likely to be frequent or occasional users of web 2.0 services associated with producing, sharing or commenting on scholarly content. Again, this is not surprising, since many services are designed to facilitate communication across geographical and institutional divides, and collaborative networks themselves help to spread ideas about the utility of web 2.0. Conversely, those not involved in collaborative research are much less likely to use such services, perhaps because they have a lower incentive to adopt.

Work as part of a local team
Work with collaborators in different institutions
Participate in informal, local research network
Participate in wider, discipline-based research networks
Do not do collaborative research

Figure 5:
Frequent, occasional and non-users' involvement in collaborative research



Country	Percentage
U.S.	100%
France	100%
Germany	100%
Spain	100%

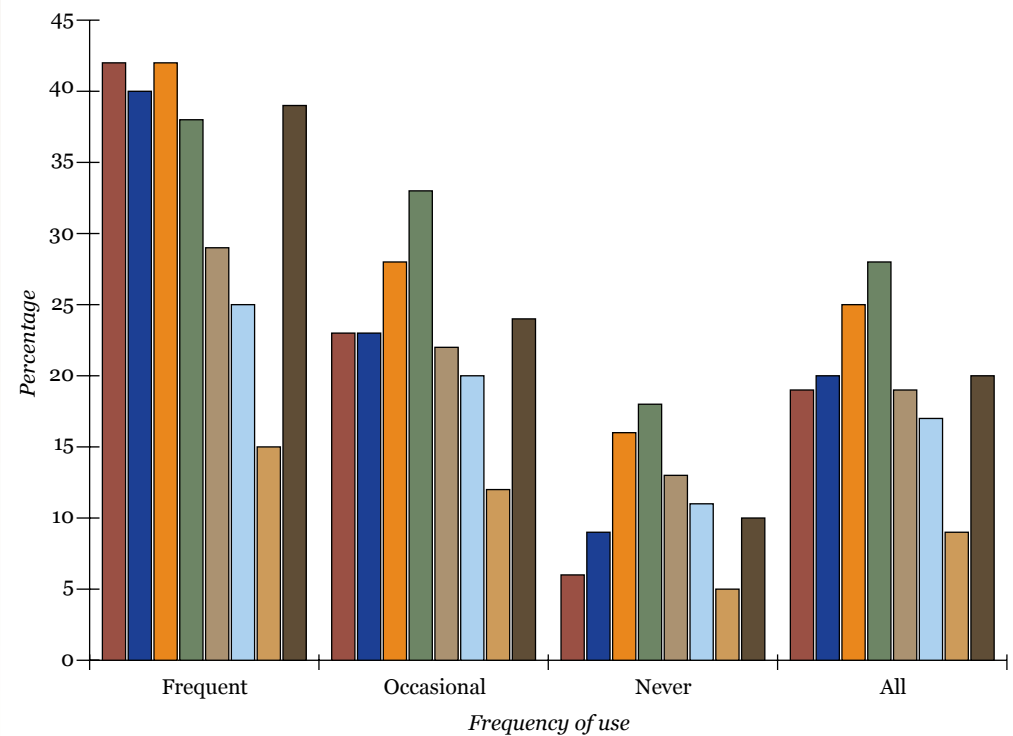


Contours of adoption

One of the principal differences between the groups is the perceived level of encouragement from local research groups and departments (see Figure 7). It is perhaps not surprising that those who make little or no use of web 2.0 services report that they receive little encouragement or support for such use. What is most striking about the responses is the importance for frequent users of support from their research group and from conference organisers; and for occasional users of support from their local library and information services.

Local research group
Department
Institution
Library & information services
Computer support services
Research & funding councils
Other funders
Conference organisers

Figure 7:
Frequent, occasional and non-users' perceived level of support



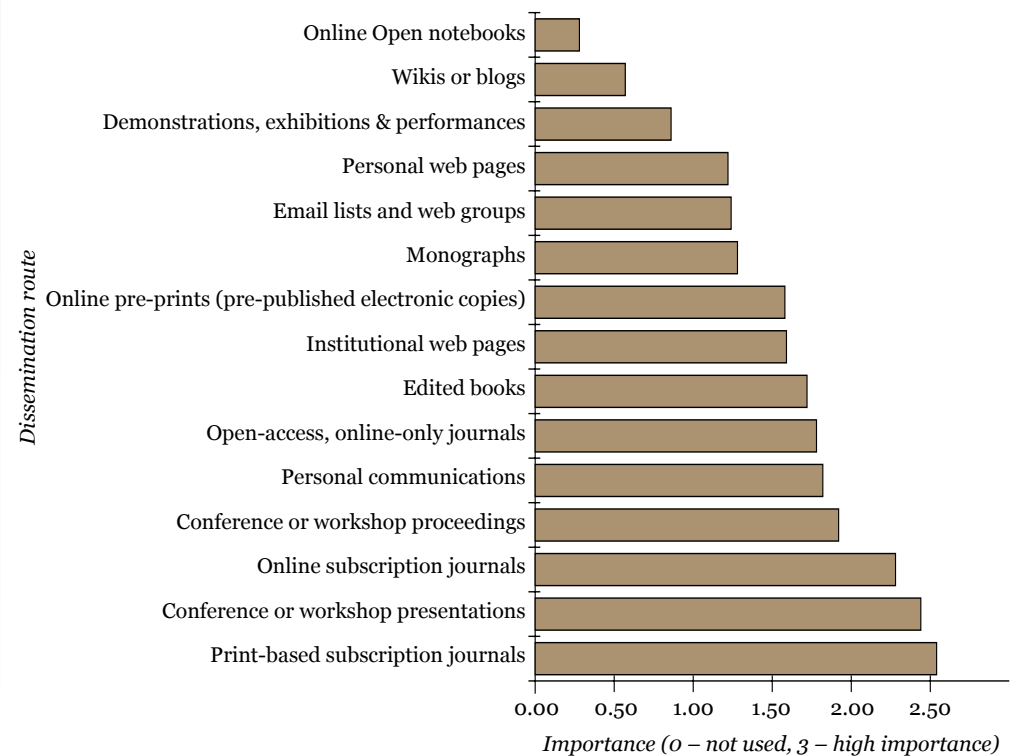
Contours of adoption

4.2 Dissemination choices

Adoption of web 2.0 tools and services for producing and sharing scholarly content needs to be set, of course, in the wider context of the available channels for scholarly communication. In deciding when, where and how to disseminate their work, researchers are motivated by a number of considerations, including the desire to maximise dissemination to a target audience; to register their claim for the work they have done; to gain recognition and esteem from their peers, along with the career rewards that flow from that; and to secure positive evaluations of their work in formal assessments. For many such reasons, researchers tend to be conservative in their choices, particularly in disseminating work that may be formally assessed and used, for example, to inform appointment and promotion decisions.

Thus, in line with earlier surveys, when our respondents were asked to rate importance of different channels of communication, they focused on conventional peer-reviewed journals. However, it is notable that, as shown in Figure 8, conference and workshop presentations scored almost as highly. There is also significant difference between researchers' valuation of print and of online-only subscription journals: print subscription journals are rated as very important by 70%, compared with 56% for online-only subscription journals, emphasising once more the value attached to the more traditional forms of communication. It is important also to note that there are considerable variations across disciplines in the value attached to different communication channels, with conference proceedings dominating in areas such as computer science and engineering, and monographs in the humanities.

Figure 8:
Importance of different dissemination routes



There are far fewer researchers, of course, who write blogs as distinct from reading them. Nevertheless, 12% of our respondents write blogs at least occasionally; 20% comment on journal articles and 21% comment on blogs, while 17% contribute to a public wiki, and 15% contribute to a private one. Posting slides and other content on publicly-available services is a familiar activity for many researchers, with 30% of all respondents doing so at least occasionally (see Table A, p.20).

In some cases, attitudes have been shaped by perceived failures in attempts to exploit new tools and services, and consequent disappointment that benefits had ‘never really materialised.’

Those who do use blogs do so for a number of different purposes – to share information about a specific research project for a defined group of readers, for example, or to write about a research field for the broader academic community, or for those outside it. Frequent users run blogs to raise the profile of their work and lay foundations for future collaborations:

‘There are career benefits too. Those ... who are actively using these materials and are perceived to be on the “cutting edge” are often very successful.’

‘It almost offers you a half way house in that you can be less formal, you don’t have to have completed your research project, you can talk about your research findings ... and it’s put out there in the public space and people can comment or interact without having to wait until your final output is a journal article that will appear in print.’

Contours of adoption

It is also notable that some frequent bloggers also use them for broader discussions of policy, though these may be restricted to specific groups or communities.

‘Blogs are good for discussions about policymaking and planning where science goes in the future. This is good for bouncing ideas around the community. Some of these are closed because some of the discussions are sensitive and they want the people involved to be free to say what they want.’

But even some frequent users are uncertain about the value of novel forms of scholarly communications:

‘People are very keen to have unconventional dissemination practices, but I think it all boils down to whether they will be valued ...’

Some non-users go further, and believe that novel forms of scholarly communications bring no benefits or are even a ‘waste of time.’

‘I’d rather spend the time thinking about what I’m going to do next rather than spend it telling others what I’m doing... I think it’s definitely a younger person’s thing.’

These findings demonstrate that while researchers may tend to conservatism in their choice of publishing outlets, a significant proportion of them also believe that benefits may come from relatively unconstrained early dissemination and discussion of their ideas and their findings. The key requirement is that this must be done through means that do not prejudice subsequent formal publication and the recognition and assessments that flow from this.

Even some frequent users are uncertain about the value of novel forms of scholarly communications.

Contours of adoption

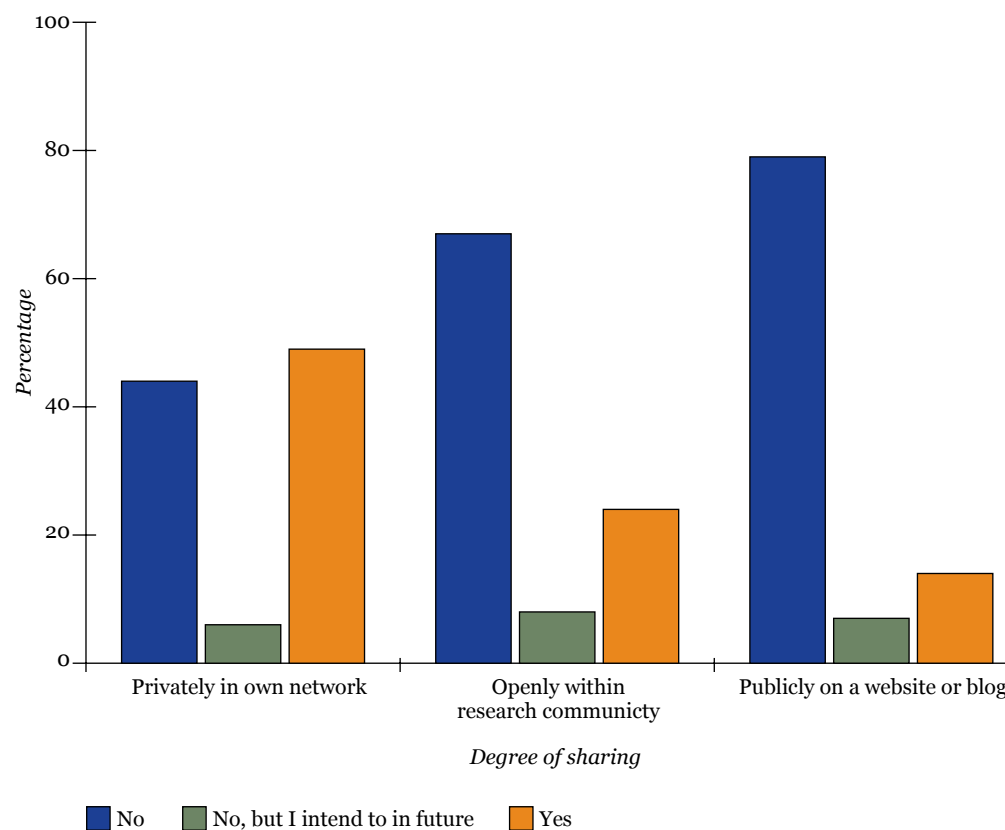
4.3 Open science?

Considerations relating to recognition and formal assessments arise also in the context of the growing interest in the last two-three years in concepts of open science or open research. This encompasses not only open access to scholarly literature, but also access to research tools (such as cell lines, reagents and so on) and to research data and protocols. The key contention is that data and tools from publicly-funded research should flow into an open infrastructure that supports and encourages reconfiguration and integration, and use by both professional researchers and the taxpaying public.⁴

Our survey asked respondents whether they were adopting key open science practices such as sharing data or publishing work in progress. As Figures 9 and 10 show, the numbers of researchers doing so are as yet very modest; and although there are some variations between disciplines, they tend to be restricted to small groups of collaborators. About half of all respondents share the outputs of work in progress with a group of collaborators, and just under a quarter share such outputs more openly within their research community – though this may reflect the way some disciplines use conferences to present work in progress. The number making such outputs publicly available to everyone is much lower, in line with use of personal web publishing. Numbers sharing data are lower still.

⁴ See *Principles for open science* drafted by Science Commons: <http://sciencecommons.org/resources/readingroom/principles-for-open-science/> [Accessed 7 June 2010]

Figure 9:
Percentages of respondents publishing work in progress



Contours of adoption

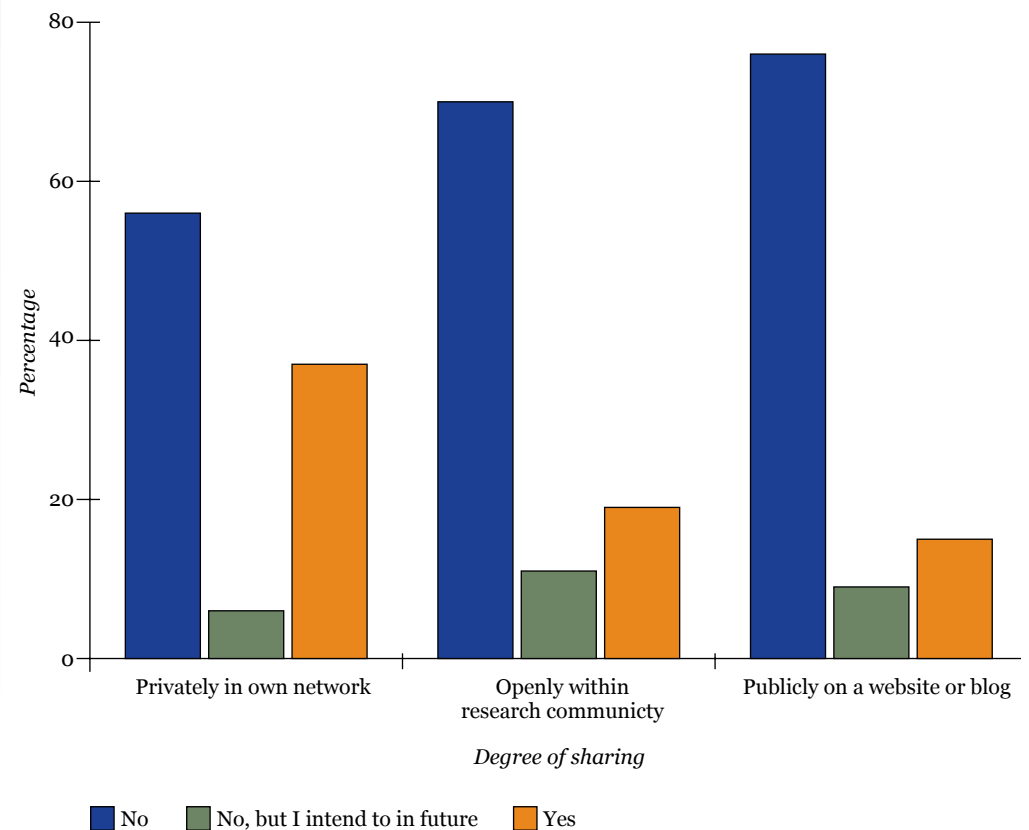
Further analysis of the survey responses suggests that there is a small group (66, 5% of all respondents) of open researchers who publish data and work in progress openly using blogs and other tools. Over half of them (55%) are among the frequent users of the other kinds of web 2.0 services we have analysed. But 36% of them are only occasional users, perhaps because they do not have data and other work that they wish to share on a frequent (weekly) basis; and 9% are non-users of web 2.0 content-sharing tools and services, presumably indicating that they are publishing their work through other means such as a personal or institutional website (see Table 13, Annex).

Operating as an open researcher is positively associated with older age groups, with men, and with discipline: researchers in computer sciences and mathematics as well as arts and humanities are more likely to operate in this way, and those in the medical and physical sciences less so.

Open researchers see new forms of scholarly communication that facilitate collaboration as an important incentive for the adoption of web 2.0 tools and services.

‘You can have a “conversation” of more than just two-way. Other people can be watching the conversation. That’s quite useful. They can contribute if they want; but you can always make it private.’

Figure 10:
Percentages of respondents making data available online



‘Ultimately it will change how people do research’ and
‘It is about accelerating the research cycle for small pieces of
research that are easily distributed’

‘I presume it’s concerned with the production of papers and research materials that [are] placed in some publicly accessible place. I support it, yes.’

‘In our university we have a guideline on what may or may not be put onto the blog. I have to agree that something needs to be saved and I don’t want people to say: we just discovered X.’

‘I do not support open science and I do not see any benefits for me. I have a negative attitude to blogs and videos in research. Once it’s finished it should be published, otherwise it will be anarchy in science.’

Of course, researchers are not just interested in producing and communicating information about their research, and web 2.0 tools and services have the potential to facilitate other

‘One of the key social skills for the 21st century is building and maintaining your networks ...’

‘the more people can connect and collaborate, the better.’

Contours of adoption

producing, sharing and commenting on scholarly content that we have discussed so far: 31% of the social networking group are frequent users of such services; but 49% are occasional users, and 20% are non-users. Frequent use of social networking services does not therefore imply frequent use of other kinds of web 2.0 tools and services, or innovative attitudes and take-up of new channels for scholarly communication. Thus while there is overlap between the two groups, social networkers are not necessarily innovative communicators.

Both age and seniority seem to play a significant role in propensity to use social networking services frequently, much more so than in the propensity to use web 2.0 tools to communicate scholarly content. PhD students and respondents in the under 25 age band are more likely to make frequent use of social networking services, and professors and those in the 55-64 age band less so (see Tables 14 and 15 in Annex). There are also notable disciplinary differences: frequent use is more common in computer science and maths, and economics and social sciences, and less common in medical and physical sciences. Again, we have not undertaken a multivariate analysis, so we cannot assess relationships between variables such as age and seniority.

Interviews confirm that researchers use social networking tools for a variety of purposes including keeping in contact with colleagues, helping to manage projects, and as an aid to dissemination (for example, providing notification of events).


Blogs can also be used for similar purposes. One of our interviewees is a regular user of Nature Blogs in this way:

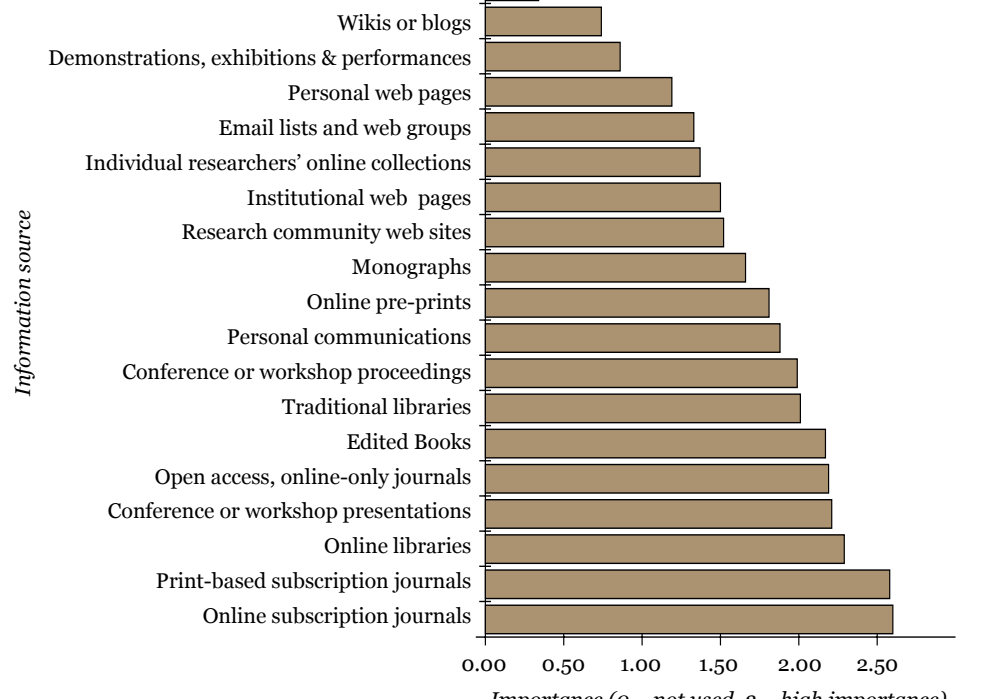
‘for searching for and about information regarding our research, with our collaborators (...) it’s very useful because you get to know what other people are doing, getting to know [a] network of people. ... and if they are doing similar things to us, we can get in touch and ask questions and share ideas.’

Others suggest that we are as yet in the early stages of thinking through the potential of social networking tools:

‘I think this whole idea of using social networking tools in science is intriguing and we’ve really only begun to scrape the surface because, at heart, a lot of science is a social networking exercise. It’s quite a good model for science when we finally get our head around it and I’m only beginning to start to understand that, I think.’

Researchers are not only producers but also consumers of information, and web 2.0 tools

Online Open matches 



Contours of adoption

But there are important disciplinary differences in formats and sources. Monographs and edited books – formats that are currently not widely available online – are much more important in the humanities and social sciences than in other disciplines. Conversely, online pre-prints have gained wide acceptability in some areas of the physical and life sciences, but not in others, so while 62% of our respondents rated as them as of average or high importance, 18% did not use them at all.

In the life sciences, the leading open access publishers such as the Public Library of Science (PLOS) have become popular and respected sources, treated like any other online journal, but with the benefits that come from speed of publishing and open access:

‘Speed, availability of information and doesn’t have any costing, it’s free.’

‘Well, to me, this is another journal, and is getting increasingly high profile and a reference source, but I don’t discriminate between that and more traditional journals.’

Perceptions about the quality, scholarly merit and sustainability of content are key factors in researchers’ assessment of new sources such as Wikipedia or blogs. Non-users are dismissive of these as a waste of time and unreliable.

‘[I] wouldn’t use Wikipedia or anything like that. Anything that isn’t peer reviewed like that is worthless’.

Thus our survey shows blogs, wikis and specialised tools such as open notebooks as lowest in use and perceived importance. Even syndicated blogs and those associated with established publishers were described by some researchers as ‘entertainment’ and regarded as more suited for discussion of policy and administration, rather than ‘science’ itself.

‘[Blogs] are not very taken seriously, even blogs based on Nature.

[Colleagues] find it time consuming and not very credible.

Interesting, yes, but ... as a piece of entertainment first and potentially useful almost serendipitously.’

Ease of discovery and access in getting to the information resources relevant to their needs, and in keeping themselves informed of events and publications in their fields, is critically important for researchers. Most of them use a range of sources and services, including mailing lists and field-specific services – such as PubMed and PubMedCentral in the biomedical sciences – as well as Google Scholar, which is seen as particularly useful for finding ‘what is new’. They also use personal networks:

‘A lot of the articles that I pick up in journals are through verbal face to face recommendations ... if someone in my area ... would say that this article is important ... then I would take that on board and look at it.’

Frequent users of web 2.0 services are distinctive in highlighting the usefulness of new sources at early stages of research, when they are attempting to survey wide areas of literature and to learn about research communities beyond their personal networks.

Contours of adoption

In contrast to the sceptics, some of the frequent users make use of blog aggregation services, such as Nature.com blogs, that make discovering good quality blogs relatively easy. And one commented on the value of web 2.0 tools for 'social filtering' in order to cope with the deluge of information:

‘It is about filtering the information coming in.’

4.6 Peer review and quality assurance

We have already seen that perceptions of quality and scholarly merit are key factors in researchers' decisions on the use of different channels for scholarly communication, both as producers and consumers of information. Peer review is seen as the key mechanism for quality assurance, and indeed as fundamental to the research process.

‘I think peer-review is essential ... I think a lot of publications that I can use somehow are less useful because of suspicion that they were not peer-reviewed. It might not be common for areas where people put their materials online.’

There are, however, concerns about how peer review operates in practice, and there is a widespread view that the rise in the volume of research and of publications is putting the peer review system under increasing pressure:

‘I think the current system is unsustainable because of the demands of work load and the peer review process.’

Table B:
Expectations of change in scholarly communications over
the next five years by frequency of use of web 2.0 services

	Frequent	Occasional	Never	All respondents
Existing peer review processes will become increasingly unsustainable				
No opinion	14%	17%	23%	19%
Unlikely	45%	56%	55%	54%
Likely	39%	26%	22%	26%
Formal peer review will be increasingly complemented by reader-based ratings, annotations, downloads or citations				
No opinion	10%	17%	28%	20%
Unlikely	23%	35%	33%	33%
Likely	65%	48%	38%	46%
New types of online publication, using new kinds of media formats and content, will grow in importance				
No opinion	5%	10%	13%	11%
Unlikely	13%	12%	13%	13%
Likely	81%	77%	73%	76%
Open access online publication supported by an 'author-pays' funding model will predominate				
No opinion	31%	32%	41%	35%
Unlikely	50%	45%	39%	43%
Likely	17%	22%	19%	20%

Owing to non-responses, percentages do not sum to 100% for each question

Contours of adoption

Table B shows that a significant minority (26%) of respondents therefore expect that peer review will become increasingly unsustainable within the next five years; and nearly half (47%) expect that peer review will be complemented by reader ratings, citation rates, etc. In both cases, expectations of change are higher among frequent users of web 2.0 services for the sharing of scholarly content. It is also notable that a clear majority of all respondents expect that new forms of publication will become increasingly important.

Unsurprisingly, opinions are divided on whether reader ratings, comments and annotations would be useful and trustworthy supplements to traditional peer review:

‘Things like citation rates ... can be tracked ... but reader comments and ratings would be so open to abuse it’s hard to imagine that people would interpret them as a valid [indicator] of the paper’s worth.’

The implication is that while researchers trust personal recommendations, perhaps even if they come via a web 2.0 service, they are less likely to trust aggregate, ‘crowd-sourcing’, recommendations.

Publishers such as PLoS are seeking to achieve the best of both worlds by integrating new services (fora, blogs, ratings, comments and so on) into peer-reviewed publications. They are thus seeking to add value to conventional journal articles by surrounding them with additional information, but not to displace peer review. So far, however, providing ratings or comments on articles has not proved popular. Readers may be reluctant to leave ‘throw away’ assessments that might themselves be assessed at a later date by other readers or even members of promotion boards.

Opinions are divided on whether reader ratings, comments and annotations would be useful and trustworthy supplements to traditional peer review.

5. Case studies of web 2.0 for scholarly communication

Case studies of web 2.0 for scholarly communication

In order to understand how and why new web 2.0-based services for scholarly communications are being developed, we conducted five short case studies.

These give an insight both into the motivations of developers and their development practices, and also into the feedback from, and their interactions with, users and other stakeholders. We also interviewed researchers about their use of these services, and about their wider information and communication practices.

The case studies (see p.40 and 41 and Table C) were selected from across a range of disciplines, in the light of the responses to our survey and interviews. They span various types of organisations involved in developing web 2.0 services used by the research community, from small-scale community-based projects to global commercial services.

Nature Publishing Group (NPG)⁵ and the Public Library of Science (PLOS)⁶ illustrate how both commercial and not-for-profit publishers of peer-reviewed scholarly articles are exploring new ways of facilitating access to and use of papers and the data associated with them.

SlideShare⁷ is a California-based start-up providing advertising-funded hosting of slide presentations. It therefore deals with more informal types of communications.

⁵ <http://www.nature.com/>

⁶ <http://www.plos.org/>

⁷ <http://www.slideshare.net/>

⁸ <http://www.myexperiment.org/>

⁹ <http://www.arts-humanities.net/>

Finally, two publicly funded projects in the UK, myExperiment⁸ and arts-humanities.net , are attempting to provide a range of new services to researchers. myExperiment⁹ is a Virtual Research Environment (VRE), funded by JISC, that enables researchers to upload and share digital research resources such as ‘workflows’. arts-humanities.net, funded by JISC and the Arts and Humanities Research Council, describes itself as an online ‘hub’ for UK researchers working in digital humanities.

PLOS is the most heavily used of the case study services, especially by researchers in the life sciences and medicine. Over half of all respondents working in those fields make use of PLOS journals at least occasionally, though as we shall see later, take-up of some of the tools for reader-generated content has been patchy so far.

<p>PLoS, PLoS One and Article Level Metrics</p> <p>PLoS is a ‘non-profit organization of scientists and physicians committed to making the world’s scientific and medical literature a public resource’. It was founded</p>	<p>Nature Publishing Group (NPG)</p> <p>Nature Publishing Group (NPG) is a medium-sized academic publisher, specialising in science and medicine. Its lead journal, <i>Nature</i>, has been used as the basis of</p>	<p>SlideShare</p> <p>SlideShare is a commercial service for uploading and sharing presentations, with additional community/social networking features. It currently has about 25 million</p>
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PLoS is a 'non-profit organization of scientists and physicians committed to making the world's scientific and medical literature a public resource'. It was founded in 2000 by three leading biomedical scientists who were frustrated by conventional publishing, with the aim of promoting open access in order to widen use of scientific research. It produces five leading open access journals in the bio-medical field, attracting researchers by offering fast turn-around times, and providing a platform for them to comply easily with funders' open access requirements. In 2006, the journal PLoS One was founded to develop a process of continuous publishing of peer-reviewed articles without editorial selection dictated by space constraints. After a number of years experimenting with functions such as commenting, rating, and links to social bookmarking and blogs, in 2009 a strategy was developed systematically to explore the possibilities of article level metrics. This allows the impact of individual articles to be judged, as distinct from the 'impact factor' of the journal as a whole. 2009 also saw the creation of PLoS Currents, a 'pre-publication' online system operated in partnership with Google to provide a moderated forum for timely but so far un-reviewed work.

Nature Publishing Group (NPG) is a medium-sized academic publisher, specialising in science and medicine. Its lead journal, *Nature*, has been used as the basis of considerable expansion in traditional and new formats. NPG took a strategic decision actively to embrace innovation in scholarly publishing, with the goal of becoming a 'science communication company' and to 'increase the speed of scientific discovery by improving scientific communication'. Its on-line journals portal Nature.com has in the last 5 years been augmented with a range of new services, including Nature Blogs (a blog aggregator), Nature Network, audio and video content, online databases, wiki-style article editing and social bookmarking. Not all of these have been successful, but they have provided valuable feedback about usage and users. To develop these services, NPG expanded its web development team, recruiting a number of developers with expertise in web 2.0 media development to create what is widely regarded as one of the most expert teams in the field. Its leader, Timo Hannay, has played an active role in promoting the ideas and services to the scientific and publishing community at large.

SlideShare is a commercial service for uploading and sharing presentations, with additional community/social networking features. It currently has about 25 million visitors every month, 3 million of those being registered users. About 25% are academic users. The SlideShare vision is to create an easy-to-use, web-based service for all who want to share their presentations publicly, especially when the presentations cover material that will not be published in other ways. Rich metadata (descriptions, tags, comments etc.) can be attached to enhance the content and enable 'social curation'. Slides can be embedded on a user's own blog or webpage. The site is owned by a venture-capital-funded company, and finances itself through advertising and through subscription-based premium services aimed at corporate users. The service was launched in October 2006 and since then, based in large part on feedback from users, additional functionality has been added, such as synchronizing audio files with presentations. SlideShare has a number of formal collaborations with other services and companies (providing plugins for Facebook, LinkedIn and PowerPoint) to make it more easily accessible across services, platforms and tools, but currently there are no strategic collaborations with the academic sector.

Case studies of web 2.0 for scholarly communication

myExperiment

myExperiment is a web-based service that enables scientific researchers to share and discuss their experiments. It is funded by the JISC 'Virtual Research Environment' programme. It was developed by myGrid, a multi-institutional research team which develops e-Science services. It is based upon the idea of sharing scientific workflows and other research objects and methods via a website. While the service was initially developed in collaboration with bioinformaticians, its subsequent development has been driven by expanding to a more generic service. It has 3000 registered users. myExperiment is an experiment in itself, based on challenging the notion

that 'scientists don't share' by building a tool that allows sharing and collaboration, and is sensitive to the needs and requirements of its users. The design of the tool – adaptive, responsive to user requirements, interactive, easy to use – is closely drawn from web 2.0 principles. Rather than build a 'perfect' version straightaway, the service was designed to evolve in response to user feedback. In 2009, myExperiment secured another two years' funding for enhancements to include more variety in the items that can be shared, bundling items into 'packs' that contain the various artefacts of the research process, the institutional integration of the service, and integration with other web-based tools.

arts-humanities.net

arts-humanities.net is an 'online hub for research and teaching in the digital arts and humanities' that provides repository and online information services. It is managed by the Centre for e-Research at King's College London and funded by JISC. It is based on two earlier short-lived services funded by the AHRC and is still in early days of development. Users are mostly from the academic sector, including librarians and others working in academic support. Other significant groups include artists and people working in the arts. In June 2010 there were 1500 registered users. The site is sustained by a core group of about 50 people who regularly contribute via email or the site's forums about topics within their field and also about how to improve the site itself. A larger group of users contribute occasionally, for example by announcing or updating information about projects and events; but the majority who visit the site do not contribute content. The main challenges for the service are financial sustainability and integration in to the network of existing expert centres and the European digital infrastructure.

	Organisation	Focus	Content	Discipline
Nature	commercial publisher	new ways to communicate research, adding value to publications	conventional publication formats, blogs, networks, social tagging	science & medicine
PLoS	non-profit open access publisher	new ways to communicate research, adding value to publications	conventional publication formats, reader comments and ratings	life sciences
SlideShare	commercial start-up	new ways to communicate research, content sharing, social networking	presentations, forums, social tagging	neutral
myExperiment	community-based start-up	new ways to communicate research, content sharing and curation, social networking	new publication formats, new forms of review	science
art-humanities.net	university sector	community building and knowledge sharing, social networking	new publication formats, forums, blogs	arts & humanities

- I) people who upload content (a small minority at the top of the pyramid, 'probably 4% or 5%');
- II) people who synthesise content by commenting on it, tagging it, forwarding it – in the end multiplying its availability across different networks (approximately 20%);
- III) the great majority who simply watch or download presentations: 'they watch and then they go away'.

Case studies of web 2.0 for scholarly communication

5.1 Innovation and the role of users in creating web 2.0 services

All five services follow the web 2.0 ethos of the ‘perpetual beta’, making early, simple versions available to a user community which experiments and ‘co-produces’ new tools, services and content in a more or less continuous process. Professional developers engage with a core group of enthusiasts and a broader base of more casual users through continual use of email feedback, service blogs, discussion fora and training programmes.

The development of the five services has tended to focus on the needs of groups of core enthusiasts, often from within specific disciplines where users are active in providing ideas, feedback and innovations in use. PLoS, NPG and myExperiment all highlight specific communities, notably in bio-informatics and chemistry, who are enthusiastic users and co-innovators of the services they develop.

Continuing engagement with communities of users is essential for service providers, since it drives innovation as well as use. But dependence for feedback and ideas on a small number of heavy users can create tension between serving what might be the complex and sophisticated needs of core enthusiasts, and engaging with occasional users (and potentially new ones), who might have different needs. In order to benefit from the network effects that generate growth in both use and innovation, providers must have effective outreach strategies that help to find ways to align their tools and services with the needs and practices of new and broader communities.

One way is to seek adoption by high-profile users, a strategy actively pursued, for example, by myExperiment. This approach can also help to generate use across national boundaries, which may otherwise be a challenge for nationally-funded projects. It is also important to engage gatekeepers such as universities and leading research centres, learned societies, and the funders of research. PLoS and NPG highlight the role of champions: for PLoS, the leading scientists who launched the service and drive innovations, and for NPG, the work of a web 2.0 ‘evangelist’ promoting the vision in scholarly and policy circles.

Services may be based on relatively stable platforms, such as Nature.com, that provide mature core services, while making space for the development of more experimental features. This distinction is visible not only at the technical level but also in the way that providers deliver new functionality and try to insure against potential failures in innovation. New developments are often initiated by looking at existing services and adapting them to the needs of both new and existing users.

Because user communities can be heterogeneous and the markets for specific features small, development is often multi-dimensional, pursuing many avenues at the same time and selecting successful features that gain sufficient use and good feedback. Important innovations are not only in the types of resources being provided, but also in how they can be used and exploited. Some services are at the forefront of developing new ways of measuring impact, such as PLoS’s article level metrics or myExperiment’s emphasis on attribution.

Changes are usually incremental, for a number of reasons. Introducing changes without input from users may conflict with existing practices and be rejected. Moreover, it takes time for new practices to develop around new features, especially if these radically challenge

The web 2.0 style of development also provides the opportunity for rapid feedback on new features before steps are taken to develop them fully. This facilitates the management of risk because it allows early evaluation, enabling service providers to take corrective action if a feature is not widely adopted. Thus our five services have made a number of decisions to pursue some paths of development and to sacrifice others which seemed to show low levels of uptake and return on investment.

The five services are all at a relatively early stage in their development, in terms not so much of technical implementation, but of the development of stable user communities and patterns of usage. We cannot therefore predict how they might develop for the future. We have already noted that existing users may depart if development does not proceed incrementally. But a too-rapid rise in popularity brings dangers too, with services being overwhelmed, resulting in a degraded user experience just at the point when new users are joining.

It is important to note also that this applies not only to the technical aspects – servers being overloaded – but also to the social organisation around the service, such as the provision of peer review or support. Web 2.0 technologies allow relatively small groups of people or even individuals to create tools and services that are available to a vast number of potential users without the costs usually associated with large-scale service deployment. In developing the initial technical functionality, size does not matter very much. Once a service gains users, however, the work required to develop and sustain technical functionality may grow significantly. It is therefore crucial for service providers to identify resources and mechanisms that allow for growth and sustainability.

Case studies of web 2.0 for scholarly communication

Providers of web 2.0 services also need to develop an understanding of the disciplinary practices and the wider cultural challenges associated with use of their services. These may include challenges to established ways of evaluating quality and impact, for example, or issues to do with intellectual property rights or data protection. Providers may need to provide advice to potential users on such issues, or on mechanisms for attribution or on data curation; for many of the innovative uses of web 2.0 services are not yet embedded in the scientific community, and challenges to established channels of communication and the values associated with them will need to be addressed.

Larger organisations which seek to develop and introduce web 2.0 services may also face challenges related to their established divisions of labour and working practices. This may lead to tensions and lack of support, especially where established editors or other staff see themselves as more in touch with the needs of their communities. On the other hand, web 2.0 services can be a useful information source for providers seeking to develop a range of other activities. Developing a strategy to secure support from within the organisation, as well as effective exploitation of the potential of the new web 2.0 services, is thus crucially important.

The Nature strategy illustrates the tensions that publishers can experience. On the one hand, NPG is developing a platform as its customers' main point of entry to its products and services, which allows them to discover and discuss research via a range of resources published under the Nature brand. On the other, NPG realises that Nature.com is simply a node in network of scholarly communication, and that users are just as likely to find synergies between resources outside Nature as within that platform. So it is important to make it easy for users to link their use of Nature to other resources and services. NPG is therefore embracing open data standards to ensure that Nature.com remains a key point of passage for researchers.

Despite the potential of web 2.0 services to disrupt existing scholarly communication practices, however, the role of traditional publishers and of peer-reviewed journals remains strong. The development by well-established publishers of new platforms and services such as blogs and forums may indeed help to increase the status and visibility of their publications and of those who contribute to them. In order to maintain their own credibility and brand, however, publishers may feel the need to exercise a degree of editorial control. Other services may delegate a greater degree of control to users, using a 'wisdom of the crowds' approach. None can avoid the need for some degree of control, however, such as white-listing of bloggers and filtering of posts and of social bookmarks.

6. Conclusions: the dynamics of adoption and use

Conclusions: the dynamics of adoption and use

Our study indicates that a majority of researchers are making at least occasional use of one or more web 2.0 tools and services for purposes related to their research: for communicating their work, including work in progress, for developing and sustaining networks and collaborations, or for finding out about what others are doing. But frequent or intensive use is rare, and some researchers regard blogs, wikis and other novel forms of communication as a waste of time or even dangerous.

The key questions for researchers in deciding whether to adopt web 2.0 tools and services as part of their everyday practice are the values and benefits they may secure from doing so, and how it fits with their use of established tools and services. Our survey, interviews and case studies all indicate that researchers who use web 2.0 tools and services do not see them as comparable to or substitutes for other channels and means of communication, but as having their own distinctive role for specific purposes and at particular stages of research. And frequent use of one kind of tool does not imply frequent use of others as well.

Demographics

Our survey findings show that those researchers who do use web 2.0 services come from all age groups and levels of seniority. This finding challenges the assumption that use of web 2.0 is for the younger ‘social network’ generation of digital natives (*Prensky, 2001*) who will lead a revolution in scholarly communications as they replace older generations of researchers.

Our survey indicates rather – in line with findings from the US (*Harley et al., 2010*) and from a UK study of young research students (*Newman, 2009*) – that younger researchers and doctoral students are not over-represented among the most active users of web 2.0 services for scholarly communication purposes, although they are among the more frequent users of social networking services. Across the whole range of web 2.0 services, the

differences in take-up and use between researchers in all age groups between 25 and 64, and from research assistants to professors, are relatively small. Our survey results do suggest that there are differences between disciplines, with computer scientists and mathematicians showing prominently among the frequent users of a wide range of services, and those in medical sciences less likely to participate. The results also suggest that relatively fewer women than men are engaging, although this may be exaggerated by disciplinary factors, notably the lower participation of women in computer science and maths.

Factors influencing adoption

The findings from all elements of our study suggest that widespread adoption of web 2.0 services by researchers depends on their being intuitive and easy to use, available free at the point of use, and incremental in building upon existing practices. Above all, they must offer both clear advantages to users and near zero adoption costs. Key intermediaries such as innovative publishers and conference organisers have been important stimulators of both service innovation and uptake. But there is some debate about whether many of the web 2.0 services for researchers – particularly social network services – provide sufficient added value to stimulate widespread adoption (*Bradley, 2009*). Our findings also indicate that few services have yet achieved the critical mass needed to achieve the network effects that stimulate pervasive use by particular communities or across the board.¹⁰

¹⁰ ‘Network effects’ (sometimes called ‘network externalities’, arise when the benefits of services for each user increase with the number of users. Services may not be viable until a critical mass is achieved (or at least until there is expectation that a critical mass will be obtained). See, for example, Arthur, W. B. (1989). ‘Competing technologies, increasing returns, and lock-in by historical events.’ *Economic Journal* 99:116-131.

Two additional factors stand out as incentives to using web 2.0 services. The first is the need for intense communication that may arise in running collaborative research projects and networks. Work of this kind often provides an incentive to explore aids to communication both within research groups and networks that operate across institutional boundaries, and also between such groups and broader ranges of stakeholders. Individual champions within a research group can play a critical role in stimulating wider adoption of innovative tools and methods.

Encouragement from colleagues is particularly important in making researchers aware not only of the services that are available, but of how they can be, and are being, productively employed to support research: researchers will not take the time to learn about and experiment with new tools and services unless they can see the benefit that might flow. Local support is thus critical to tackle the lack of time and skills which prevent researchers from investigating, experimenting and evaluating alternatives. Such support is often vital at the stage when researchers are experimenting with new services but find it difficult to see what

There are other negative influences, too. The rapid development and proliferation of services, and the constant churn of new and enhanced offerings, pose problems for both existing and prospective users. It is hard to keep track of new developments, let alone assess their potential benefits. The costs of adoption are not always trivial, and unless researchers see clear and quick benefits, they tend to keep to tools that they already use and trust. Moreover, the plurality of services results in fragmentation of the potential user base, which is especially problematic when benefits are closely related to number of users. Researchers may well defer a decision to adopt until they are sure that large numbers of their colleagues have done so. Thus the advantages for late movers may outweigh those for early adopters.

Conclusions: the dynamics of adoption and use

Possible futures

Our survey findings show that those researchers who do use web 2.0 services come from all age groups and levels of seniority. This finding challenges the assumption that use of web 2.0 is for the younger ‘social network’ generation of digital natives (*Prensky, 2001*) who will lead a revolution in scholarly communications as they replace older generations of researchers.

The likelihood of major changes in patterns of adoption and use in the future is therefore unclear. A relatively small group is making frequent and innovative use of web 2.0 services in communicating their research. The majority of researchers, however, use them only sporadically and in more limited ways, or not at all. Relatively few express scepticism or hostility to using new technologies in scholarly communications, and some of those who use web 2.0 only occasionally nevertheless express considerable enthusiasm for change. But for many researchers, the well-established mechanisms for information exchange work reasonably well. They are also, critically, entrenched within long-established institutional and professional systems for assessing and rewarding researchers’ work. Thus researchers have good reason to tend towards conservatism in choosing how to disseminate their work. While a significant minority understand that benefits may come from relatively unconstrained early dissemination and discussion of their ideas and their findings, the key requirement is that this must be done through means that do not prejudice subsequent formal publication, and the recognition and assessments that flow from them.

The emergence, adoption and use of new technologies, and the development of new uses, often involves protracted processes of negotiation and discovery:

- as potential users seek to uncover, explore and exploit new technological capacities and adapt them to their purposes and contexts; and
- as designers and developers seek to capture and better understand emerging users and usages.

In the course of such processes, technologies and conceptions of use may be changed fundamentally. Overall, however, there is little evidence at present to suggest that web 2.0 will prompt in the short or medium term the kinds of radical changes in scholarly communications advocated by the open research community. Web 2.0 services are currently being used as supplements to established channels rather than displacing them. A ‘web 2.0 revolution’ is not imminent. We are, instead, in the initial stage of a process of ‘social learning’¹¹ (*Sørensen, 1996; Williams, Stewart and Slack, 2005*) about the development and use of web 2.0 in research.

¹¹ ‘Social learning can be characterised as a combined act of discovery and analysis, of understanding and giving meaning, and of tinkering and the development of routines. In order to make an artefact work, it has to be placed, spatially, temporally, and conceptually. It has to be fitted into the existing, heterogeneous networks of machines, systems, routines, and culture.’ (*Sørensen, 1996*)

7. Implications for universities, funders and researchers

Implications for universities, funders and researchers

Adoption of web 2.0 tools and services, and of novel forms of scholarly communication associated with them, has reached only modest levels up to now. Use is both fragmented and uneven, and tends to support well-established practices. We are thus still at an early stage in the adoption of web 2.0, and the tools and services, as well as the uses to which they are put, are developing rapidly.

Moreover, the processes of web 2.0 adoption are at present often highly-localised, and thus provide an unconstrained space for innovation that is close to researcher-users. This allows for rapid incremental changes, but simply relying upon local innovation will reinforce the current uneven pattern of uptake. In these circumstances, better understanding of new and emerging practices can contribute to more effective public policies and administrative strategies to support scholarly communication. It will also help to guide the efforts of developers and service providers.

If change is to be beneficial, however, it will need to take account of and encompass some of the key features of scholarly communication that researchers most value. Established forms of communication have developed in ways which ensure that:

- they register the claim of individuals and groups of researchers to have undertaken specific research projects;
- the work and the results that are communicated are subject to some form of quality assurance, of which peer review is by far the most important;

- findings can be checked and validated by others;
- those who seek to build on other researchers' findings can acknowledge the earlier work; and those whose work is cited can gain credit for that;
- the 'records of science' in the form of publications are preserved for the long term.

Up to now relatively little attention has been paid to how these key features might be incorporated into a web 2.0 world.

In the light of all these considerations, we suggest that if experimentation and innovation are to be encouraged and supported, and not stifled, universities, funders, and members of the research community will need to:

- encourage open-ended experimentation, and avoid the risk of stifling innovation by attempts to impose particular systems or concepts of how they will be used;
- establish mechanisms through which researchers can share information about useful developments in services and tools;
- undertake further research to understand the ways in which use of web 2.0 develops;
- consider how policy and practice might be developed to ensure that innovation takes full account of – and does not undermine – the long-established key functions of the scholarly communications process, including registration, certification, and preservation.

7.1 Implications for university computing and information services

Researchers' use of web 2.0 services has often by-passed central university computing and information services; research groups themselves have often been the drivers of innovation relevant to their scholarly activities, as well as providing support to their colleagues.

Researchers' use of web 2.0 services has often by-passed central university computing and information services; research groups themselves have often been the drivers of innovation relevant to their scholarly activities, as well as providing support to their colleagues.

Information professionals should not seek to re-establish centralised provision, which might inhibit the dispersed processes of innovation and experimentation. Instead they may need to rethink their current roles and organisation, and to broaden their agendas to include effective support for web 2.0.

Their roles might usefully include:

- In developing such roles, information professionals in universities will need to recognise the key roles played by other bodies including commercial suppliers, various academic knowledge intermediaries (for example, publishers, conference organisers and scholarly organisations), and researchers themselves.

Universities can do much to stimulate experimentation and exploitation of new forms of scholarly communication. But in order to do so they must engage in a process of adapting their policies to maximise benefits while minimising risks, and to manage the trade-offs between integrity and security on the one hand, and openness and innovation on the other. University policies and service frameworks may thus need to foster a differentiated information infrastructure in which users can select environments appropriate for their types of research (depending, for example, on the weight attached to data security as against ease of communication) and which provide space to experiment with new tools and services.

We suggest, therefore, that universities and funders should seek to develop policy frameworks to encourage a balance between innovation and openness on the one hand, and integrity and security on the other, taking account of issues including:

Implications for universities, funders and researchers

- knowledge transfer and socio-economic impact, and the role that web 2.0 services might play in enabling researchers to communicate and engage with a wider range of audiences;
- confidentiality, security, and intellectual property rights, and the need to protect sensitive and valuable information assets. There is an urgent need for new policies and guidelines for researchers as they take up new forms of scholarly communication;
- assessment, recognition and reward systems, and how they may need to be changed – at national as well as at university level – to remove disincentives and to take proper account of the various new ways in which researchers can communicate and share the results of their work;
- training and staff development, and the need to ensure that researchers develop their awareness and understanding of the rapid changes in information and communication technologies, services and practices;
- the diverse needs and practices of researchers in different disciplines and communities, and the need to take account of these in flexible policy frameworks;
- data curation and sharing, and the ways in which web 2.0 services might encourage data re-use as well as new forms of information exchange.

7.3 Implications for researchers

Researchers themselves are the most important enablers and communicators of emerging best practice. It is important that they should consider the full range of available tools and services as an intrinsic part of the research and scholarly communication process, and seek to learn from each other about new developments and practices that prove beneficial. Where web 2.0 tools and services have proved useful, the researchers involved can play a valuable role in exchanging information, thereby increasing awareness of the range of available tools and services (generic and discipline specific) and their utility for particular activities and settings. Better sharing of experience about how new offerings might be usefully and effectively deployed may be key to encouraging uptake and learning about effective use.

Researchers themselves are the most important enablers and communicators of emerging best practice.

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Annex: Data tables

Table 1: Age by frequency of use

Age	Frequency of use			BASE
	Frequent	Occasional	Never	
Under 25	6%	37%	57%	49
25-34	14%	43%	43%	335
35-44	18%	45%	37%	329
45-54	11%	50%	38%	292
55-64	13%	48%	39%	219
Over 65	9%	41%	50%	54

Table 2: Position by frequency of use

Position	Frequency of use			BASE
	Frequent	Occasional	Never	
PhD student	10%	40%	50%	333
Research assistant	21%	39%	40%	57
Research fellow	14%	49%	37%	155
Lecturer	16%	39%	45%	142
Senior lecturer	13%	56%	31%	190
Reader	13%	59%	28%	92
Professor	13%	48%	39%	261

Discipline	Frequency of use			BASE
	Frequent	Occasional	Never	
Medical sciences	6%	50%	44%	195
Biological sciences	9%	46%	45%	67
Physical sciences	12%	48%	40%	199
Computer science & maths	27%	51%	22%	170
Engineering	16%	47%	36%	55
Economics & social sciences	12%	43%	45%	365
Arts & humanities	15%	40%	45%	228

Gender	Frequency of use			BASE
	Frequent	Occasional	Never	
Female	10%	42%	47%	566
Male	16%	49%	35%	712

Level of collaboration	Frequency of use			
	Frequent	Occasional	Never	All
Work as part of a local team	68%	56%	52%	56%
Work with collaborators in different institutions	73%	68%	57%	64%
Participate in informal, local research network	55%	40%	34%	40%
Participate in wider, discipline-based research networks	57%	50%	36%	45%
Do not do collaborative research	9%	14%	19%	15%
BASE	175	589	518	1282

Table 6: Frequent, occasional and non-users' attitudes towards the use of new technologies

Attitude towards web 2.0	Frequency of use			All
	Frequent	Occasional	Never	
Sceptical	6%	9%	10%	9%
Uninterested	1%	2%	4%	3%
Neutral	24%	51%	59%	50%
Enthusiastic	70%	39%	27%	38%
BASE	175	589	518	1248

Table 7: Frequent, occasional and non-users' perceived level of support

Support offered by...	Frequency of use			All
	Frequent	Occasional	Never	
Local research group	42%	23%	6%	19%
Department	40%	23%	9%	20%
Institution	42%	28%	16%	25%
Library & information services	38%	33%	18%	28%
Computer support services	29%	22%	13%	19%
Research & funding councils	25%	20%	11%	17%
Other funders	15%	12%	5%	9%
Conference organisers	39%	24%	10%	20%
BASE	175	589	518	1282

Table 8: Importance of different dissemination routes

Dissemination route	Importance*
Print-based subscription journals	2.54
Conference or workshop presentations	2.44
Online subscription journals	2.28
Conference or workshop proceedings	1.92
Personal communications	1.82
Open access, online-only journals	1.78
Edited books	1.72
Institutional web pages	1.59
Online pre-prints (pre-published electronic copies)	1.58
Monographs	1.28
Email lists and web groups	1.24
Personal web pages	1.22
Demonstrations, exhibitions & performances	0.86
Wikis or blogs	0.57
Online Open notebooks	0.28

* 0 – not used, 3 – high importance

Table 9: Percentages of respondents publishing work in progress

	No	No, but I intend to in the future	Yes
Privately in own network	44%	6%	49%
Openly within research community	67%	8%	24%
Publicly on a website or blog	79%	7%	14%
BASE	1286		

Table 10: Percentages of respondents making data available online

	No	No, but I intend to in the future	Yes
Privately in own network	56%	6%	37%
Openly within research community	70%	11%	19%
Publicly on a website or blog	76%	9%	15%
BASE	1286		

Table 11: Importance of different information sources

Information source	Importance*
Online subscription journals	2.60
Print-based subscription journals	2.58
Online libraries	2.29
Conference or workshop presentations	2.21
Open access, online-only journals	2.19
Edited Books	2.17
Traditional libraries	2.01
Conference or workshop proceedings	1.99
Personal communications	1.88
Online pre-prints	1.81
Monographs	1.66
Research community web sites	1.52
Institutional web pages	1.50
Individual researchers' online collections	1.37
Email lists and web groups	1.33
Personal web pages	1.19
Demonstrations, exhibitions & performances	0.86
Wikis or blogs	0.74
Online Open Notebooks	0.34

* 0 – not used, 3 – high importance

Table 12: Frequent bloggers by discipline

Discipline	Percentage within discipline who are frequent bloggers	BASE
Medical sciences	0.51%	195
Biological sciences	4.92%	61
Physical sciences	2.51%	199
Computer science & maths	7.74%	168
Engineering	1.82%	55
Economics & social sciences	3.56%	365
Arts & humanities	6.64%	226

Table 13: Open scientists by frequency of use

	Percentage
Frequent user	55%
Occasional user	36%
Non-user	9%
BASE	66

	Blogger	Social networker	Open scientist	BASE
Under 25	2%	17%	2%	64
25-34	4%	16%	4%	398
35-44	4%	14%	5%	385
45-54	4%	10%	4%	325
55-64	2%	4%	7%	233
Over 65	2%	2%	5%	60

	Blogger	Social networker	Open scientist	BASE
PhD student	3%	17%	2%	421
Research assistant	7%	10%	6%	72
Research fellow	2%	12%	6%	173
Lecturer	3%	12%	5%	163
Senior lecturer	3%	11%	5%	211
Reader	4%	8%	8%	96
Professor	2%	5%	4%	273

About the Research Information Network

Who we are

The Research Information Network has been established by the higher education funding councils, the research councils, and the national libraries in the UK. We investigate how efficient and effective the information services provided for the UK research community are, how they are changing, and how they might be improved for the future. We help to ensure that researchers in the UK benefit from world-leading information services, so that they can sustain their position as among the most successful and productive researchers in the world.

What we work on

We provide policy, guidance and support, focusing on the current environment in information research and looking at future trends. Our work focuses on five key themes: **search and discovery, access and use of information services, scholarly communications, digital content and e-research, collaborative collection management and storage.**

How we communicate

As an independent voice, we can create debates that lead to real change. We use our reports and other publications, events and workshops, blogs, networks and the media to communicate our ideas. All our **publications** are available on our website at **www.rin.ac.uk**

This report is available at **www.rin.ac.uk/web-20-researchers** or further hard copies can be ordered via **contact@rin.ac.uk**

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