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Researchers of Tomorrow: The research behaviour of Generation Y doctoral students

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Abstract. Some findings are reported from the three-year *Researchers of Tomorrow* study of research behaviour among doctoral students in 'Generation Y'. Commissioned by the British Library and UK Joint Information Systems Committee, it is the most intensive study of its kind to date. Generation Y doctoral students are sophisticated information-seekers and users of complex information sources, highly competent in but not dazzled by technology and acutely aware of authority and authenticity issues in research. The study indicates heavy dependence on secondary, published resources as the basis for original research, which may have implications for research quality and the 'research apprenticeship' experience. eJournals dominate across all subject disciplines; authentication of access to and licensing limitations on subscription-based resources are a source of frustration. There is widespread lack of understanding about open access. Generation Y doctoral students are not keen users of new technology applications in their research and prefer those that do not challenge existing research work practices. The majority work alone, not in research teams, sharing research outputs only with peers. Despite potential benefits of greater openness and sharing they are constrained by lack of confidence in their research work and the need for them to demonstrate originality in research findings.

Keywords: Doctoral students, PhD, research, information, technology use, open access, information services

1. Introduction

In 2007 the British Library (BL) and the Joint Information Systems Committee (JISC) funded the research study *The Google Generation: information behaviour of the researcher of the future* [1], which focused on how young people in schools, 'digital natives' born after 1993, are likely to access and interact with digital resources in five to ten years' time. The research reported overall that the information literacy of these young people has not improved with wider access to technology.

In 2009, to complement the findings of the *Google Generation* research, the BL and JISC commissioned a three-year study, *Researchers of Tomorrow*, focusing on the information-seeking and research behaviour of doctoral students in 'Generation Y' – defined in the study as those born between 1982 and 1994. Generation Y students in the United Kingdom (UK) are not 'digital natives': they were educated in schools with limited access to computers and the internet. In a largely technology-free environment, it was assumed that Generation Y acquired information-seeking and enquiry skills without learning "to 'get by' with Google" [1] and that the nature of this early start may have had an impact on their research behaviour and information-seeking skills as doctoral students.

This study is the longest and most intensive research to date on information-seeking practices and research behaviour among doctoral students, which gives it special significance in terms of the credibility of its findings. The richness of evidence was drawn from individuals telling us about and reacting to their own institutional and research environment and experiences. The research findings should have

significance and weight for a number of different stakeholders in the higher education and research sector, such as senior managers, research library staff, strategic and funding bodies and commercial and other research information service providers.

This article presents some of the findings relating to information services and use, and in particular on the doctoral students' take-up and use of technology and web-based applications in their research work. Some conclusions are drawn about the implications these findings might have for institutional and other stakeholders.

The final report of the study is publicly available at www.researchersoftomorrow.net and the survey data are publicly available in the UK Data Archive (www.data-archive.ac.uk).

1.1. Scope

The main focus areas of the study were to:

- map emerging research behaviour trends across the main subject disciplines;
- investigate how doctoral scholars seek information both on and offline;
- measure the relative use of digital resources and physical resources;
- understand how Generation Y students search for and use digital content for research,
- and if and how they use emergent technologies to do so.

1.2. Methodology

The study used a mix of quantitative and qualitative methods to gather and test evidence including three annual surveys of the wider population of doctoral students in the UK, distributed in collaboration with over 70 higher education institutions; and a longitudinal qualitative cohort study of Generation Y students.

In the three annual surveys a total of 17,113 responses were received of which 13,593 were complete and therefore used in data analysis. From these annual surveys data were derived on two samples:

- Generation Y students born between 1982 and 1994 (sample size 6161);
- older doctoral students (sample size 7432), enabling comparison with the attitudes and behaviour of Generation Y.

Figure 1 shows the breakdown of the two samples into year of study across the three annual surveys.

The Generation Y sample in each of the three annual surveys also achieved a good balance of respondents across the main research disciplines in each of the three surveys. Overall the Generation Y sample included a higher proportion of science, technology and medicine students than the older student sample: this correlates with the recent emphasis put on these disciplines in UK Government policy and research council funding and reflects national trends.

In parallel with the survey research, 60 full-time doctoral students were recruited into a longitudinal cohort study: they were a diverse group geographically, institutionally, by subject of study, funding and a range of other features. Of the 60 students who signed up over 30 remained active participants in the research to the end despite the increasing pressures of their studies.

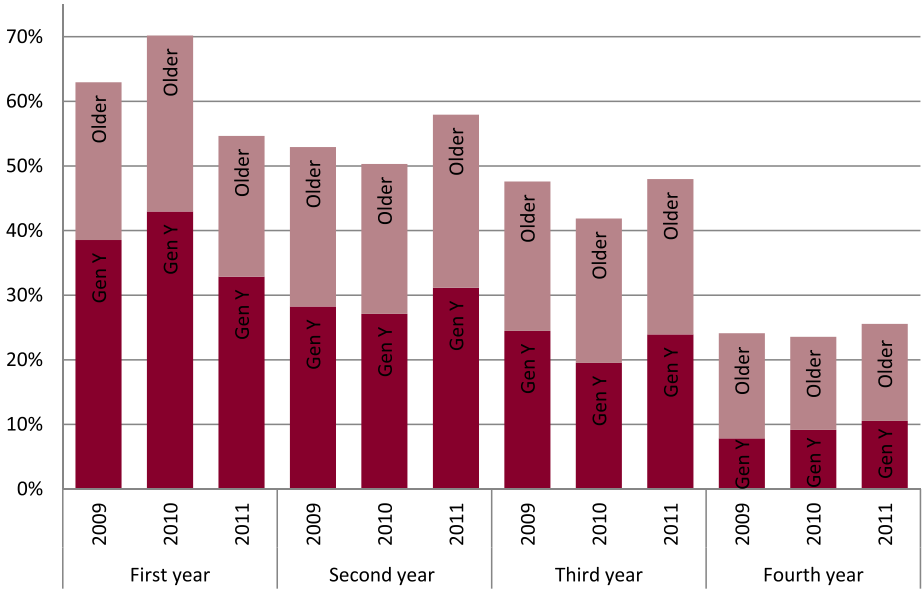

Fig. 1. Percentage of respondents by year of study across three surveys. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/ISU-2012-0637.)

2. Main findings of the research

2.1. Finding and using research resources

In 2009 doctoral students were asked to think about the last significant critical incident of information-seeking activity they had undertaken, and indicate

- what kind of research information or material they began looking for;
- what they eventually found of value through this incident; and
- the main way in which they located what they sought.

In this one information-seeking incident the majority of all doctoral students (including Generation Y) were looking for specific or any relevant bibliographic references, or any published writing on the topic in question, and only 7% failed to find anything to satisfy their needs.

Around 80% of each discipline group among students studying science, technology and medicine were looking for references to or specific published material while only around 10% of each group were looking for scientific or mathematical data. Similarly, in that critical incident about 80% of arts and humanities students were looking for references to or specific publications and only 7% sought non-published archival material, or similar material.

Most students found the information they sought in more than one kind of research resource, but ejournals dominated: Fig. 2[1] shows the responses from the two survey samples, Generation Y and older students.

The data suggest a relative uniformity in the kinds of resources and materials sought and used by all doctoral students: the overwhelming majority ended their information-seeking incident with a book

[1]Methodological note: these data are from 4900 individuals reporting on 'critical incidents' of information-seeking in summer 2009, all ages and all doctoral study years.

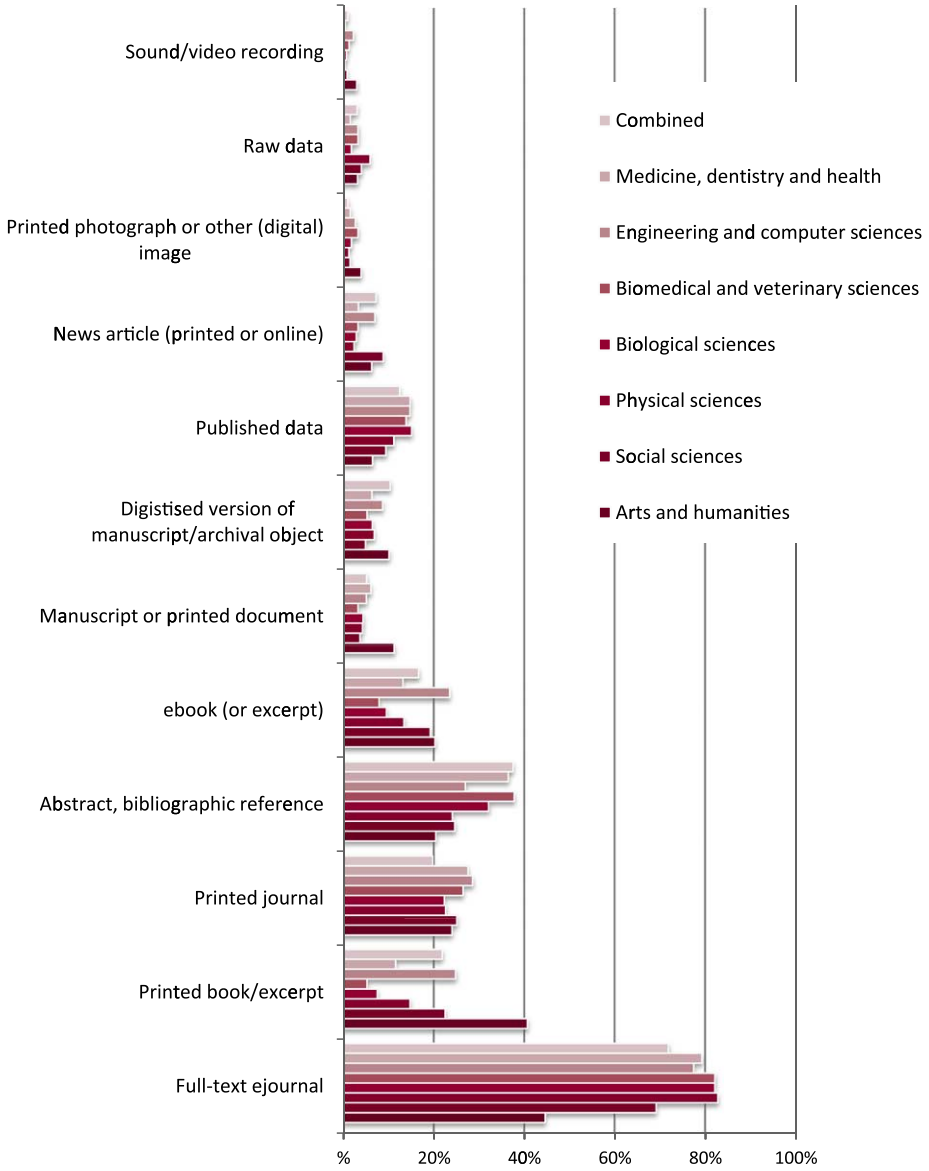

Fig. 2. Type of research resource found and subject discipline (total survey sample). (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/ISU-2012-0637.)

(ebook or print), a journal article (ejournal or print), a reference or abstract of an article, and not primary or original source material such as data, photographs or newspaper articles, or archival material.

30% of the total survey sample used Google or Google Scholar as their main source to find the research information they sought. Disaggregated by subject discipline, however, the data show some interesting differences. Google sources were strongly favoured above other sources by arts and humanities, social science and engineering and computing science students; while citation databases or ejournal search interfaces were equally as popular as Google among biological and biomedical sciences students. Arts and humanities students sourced their information from a wider spread of online and offline sources,

including library catalogues.

The cohort students rarely seemed to be aware of the actual publisher or e-information source itself when searching for ejournal articles, for example, relying on their libraries' own e-resource interface or a Google application to locate and access resources, without being particularly interested in the names or nature of the originating organisations.

They showed a sophisticated awareness of how to use the networked information environment in which they worked, locating what they needed through external as well as their own institutional portals, and from wider generic internet sites. They were aware of the potential of using other institutional library resources, both online and offline. However, many among the cohort made some early assumptions about the extent of 'joined-upness', or cohesion, of the academic library network in the UK and of access arrangements and services across the sector, which left them rather open to disappointment and frustration as their studies progressed.

2.2. Using open access research resources

Open access in this study was defined as free online access to scholarly works through the removal of price barriers and most permission barriers, making them available with minimal use restrictions (e.g. author attribution only). Overall, the cohort students were not aware of or did not completely understand what open access means, which significantly and negatively affected their use of open access research resources. There was, in particular, considerable confusion between open access and open web sources or social media.

The survey samples were asked to consider the veracity or otherwise of seven statements about the meaning and nature of 'open access' and 'self archiving' as they are generally understood in relation to scholarly communications in the broadest sense [4]. Table 1 shows the responses from the Generation Y sample: the data show little or no variation in the older survey sample.

When asked about their actual use of open access research resources, Generation Y students were slightly more inclined to use open access research resources than older students: the main reservations expressed were concerned with:

Table 1
Responses to statements about open access

	Statement	True	False	Don't know/ not stated
1	Open access is all works that are openly available on the web, which do not need any payment or permissions to look at, access or use it. [Statement not accurate in context of scholarly publishing]	66%	13%	21%
2	Open access is scholarly publishing in an ejournal without any payment requirement to access it and no, or limited restrictions on use. [Statement true]	63%	13%	24%
3	Self-archiving refers to authors depositing their work in open access institutional or subject repositories, or making material otherwise available on the web. [Statement is true]	40%	7%	53%
4	Open access journals are not peer-reviewed. [Statement is not true]	9%	55%	36%
5	Journal articles in conventional, non-open access journals are not self-archived by their authors. [Statement is not true]	18%	21%	61%
6	Research funders are beginning to expect open access to the research they support: many have already adopted self-archiving mandates. [Statement is true]	26%	6%	68%
7	Some conventional, non-open access journals provide open access after an embargo period of 6–12 months or longer. [Statement is true]	33%	6%	61%

- Quality control, reliability and currency of the sources, particularly whether or not the journal or self-archived material was peer-reviewed;
- Scholarly value, impact or academic ranking of open access sources;
- Time required to track down open access sources and likelihood of obtaining a 'proper' citation for the source.

2.3. Constraints on finding and using research resources

The cohort students indicated strongly that restricted institutional ejournal licences were a constant source of irritation, exasperation and mystification. With two or three exceptions, where students felt their subject area was well-supported by institutional resources, most of the students encountered difficulties in accessing specific journal articles through their own institution.

In the surveys doctoral students of all ages consistently ranked difficulties in accessing and obtaining relevant resources – particularly journal articles – as a relatively severe constraint on their research (see Fig. 3). In each annual survey the principal constraint – ranked from 1–5 according to severity with 5 being the most severe – emerged as time constraints, followed in severity by problems with licensing restrictions on ejournal and other e-information databases, and general difficulties in finding and/or accessing relevant research resources.

When asked what various steps they normally took when they need an ejournal or print journal article that was not available in their institution, over half of the Generation Y sample said they order a copy through their institution's inter-library lending and document supply service. About one quarter said they visit another institution to find what they needed and 47% said they ask a friend or colleague in another institution to get the article for them. 43% of Generation Y students also said they make do with the abstract: fewer older students said they do this (36%).

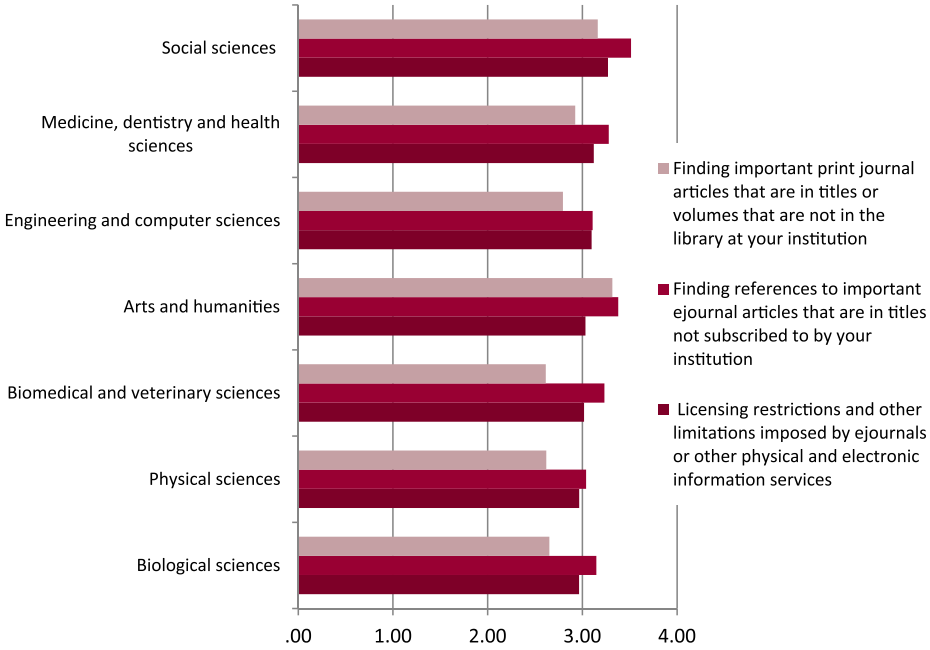

Fig. 3. 2011 mean rankings for constraints on finding resources: by subject discipline. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/ISU-2012-0637.)

2.4. Take-up of technology and applications

The majority of surveyed Generation Y students self-identified in 2009 as being in the category of 'elite technology users' in their personal lives: they had "the most information technology, are heavy and frequent users of the internet and cell phones and, to varying degrees, are engaged with user-generated content. Members of these groups have generally high levels of satisfaction about the role of ICTs in their lives, but ... differ on whether the extra availability is a good thing or not" [2].

About 39% took a pragmatic approach, 'not spending much time thinking about technology'. This overall competence and caution about technology was reinforced in the 2011 survey data: 42% of Generation Y students said they were 'careful about new gadgets, but I think I grasp change more quickly than the average person' with only 10% saying they liked to be 'first on the block, and like to try out new gadgets before anyone else'. 29% said they 'tend to be sceptical about new gadgets, I'll only get one when they have proved their worth'.

Competence notwithstanding, the surveys suggested overall low levels of use of specialist applications or web 2.0 in doctoral research, with very little difference between the ages of the students. In 2009 the survey samples were asked to say how much they used and valued a range of technology-based tools, including Web 2.0 applications, in their research (see Fig. 4).

The data show that a relatively high proportion of the Generation Y student sample had not used any of the listed technology tools for their research. The lack of take-up of technology tools in their research was clearly not due to lack of skills; evidence from the cohort study suggested that it was more likely to be because the students did not see the immediate utility within their research and to their preferred ways of working. While the cohort students relied heavily on ICT and web-based applications in some form, it seemed important to them that these new tools and applications did not transform the way they worked and wanted to work.

A more nuanced investigation of this issue was included in the 2010 survey: institutionally provided or supported technologies and applications were considered separately from open web technologies (including social media). The survey samples were first asked which of a range of institutionally supported technologies they had used during the past academic year. More than a quarter of the Generation Y sample (27%) had used none of the technologies listed; citation and reference management tools were overwhelmingly the most frequently cited applications in use (58%). All the other kinds of technologies and applications were cited by only 10% or less.

Students were then asked about their passive and active use of technologies available on the open web for their research work during the past academic year. The majority of all students surveyed had used none of the technologies listed. Overall, the data showed that passive use was much more common in than active use, i.e. reading wikis but not creating content, following blogs but not blogging oneself.

The 2011 survey focused specifically on the various potential uses of social media applications within a research setting (see Fig. 5).

Overall levels of use (including less often than monthly) of some of these tools was relatively high – for example, reference management applications (such as, bookmarking, sharing and organising references) were used overall by more than 75% of the Generation Y sample, and RSS and alerting tools, by about 60% overall.

On the other hand, those applications most useful for collaboration and scholarly communications (blogging, collaborative wikis, etc.) were among the least used of the social media tools. For example, 80% of students had never maintained their own blog for their research, and 78% had never posted to someone else's blog; over 70% had never maintained or collaborated online using wikis, and 58% had

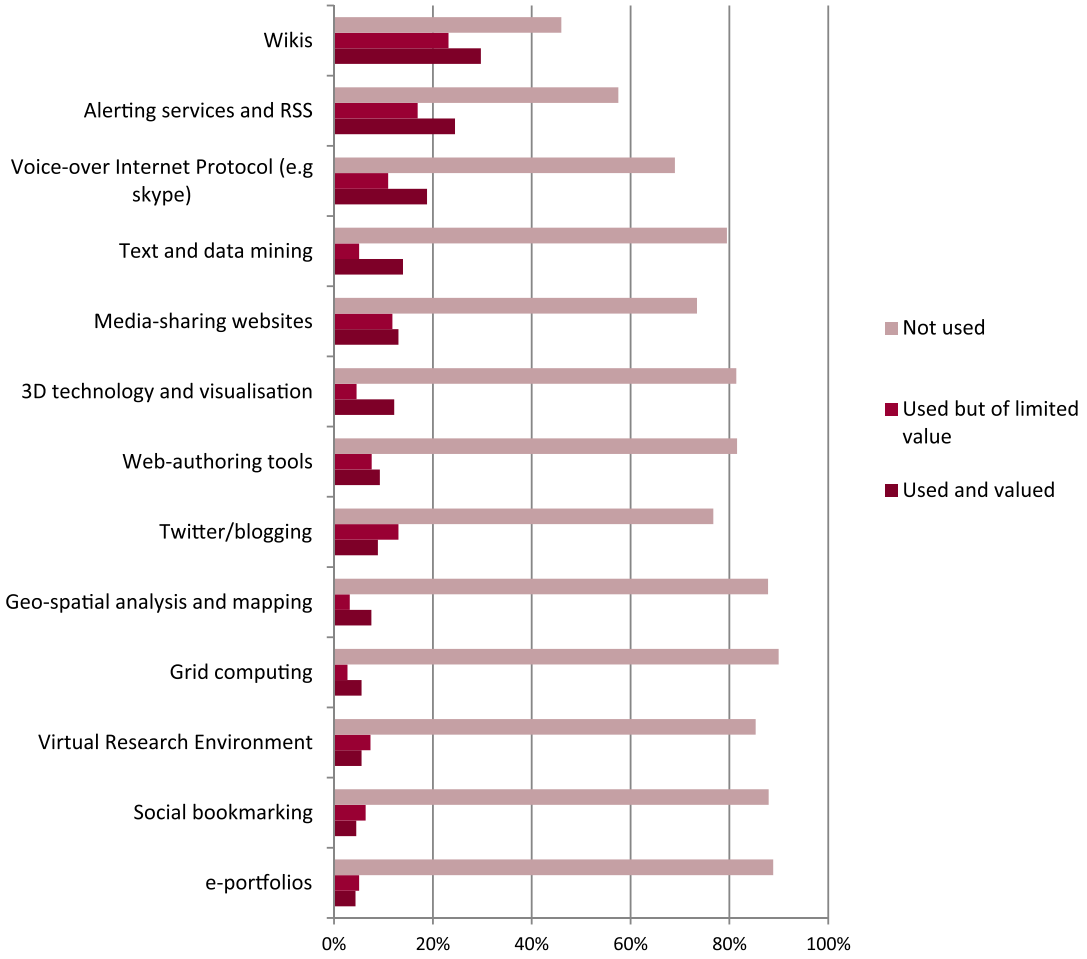

Fig. 4. Use/value of technology tools. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/ISU-2012-0637.)

never posted contributions to themed discussions. These data confirm what the cohort students indicated, that applications are readily taken-up and used if they can be absorbed into and support existing working practices.

Nonetheless, over the three years of the study the survey data reveal signs of increasing use in research for some open web and Web 2.0 technologies. There were also indications of change within the student cohort in their growing interest in using online forums and Web 2.0 applications to support their research as the study progressed. For example, towards the end of the study the majority of the cohort used Facebook in their personal lives, but most would not consider using it for their work, as this implied to them an inappropriate mix of social life and work. However, more members of the cohort were using sites such as academia.edu, Graduate Junction and Mendeley to follow-up contacts made at conferences, to make contacts or organise a conference, and to share bits of research. Several members of the cohort also used Twitter to follow or to share (e.g. one cohort member was following the Housing Minister in the UK Government). This increased use of technologies also seemed to be associated with the growing confidence of the cohort students in having some real research outputs and results to talk about, since

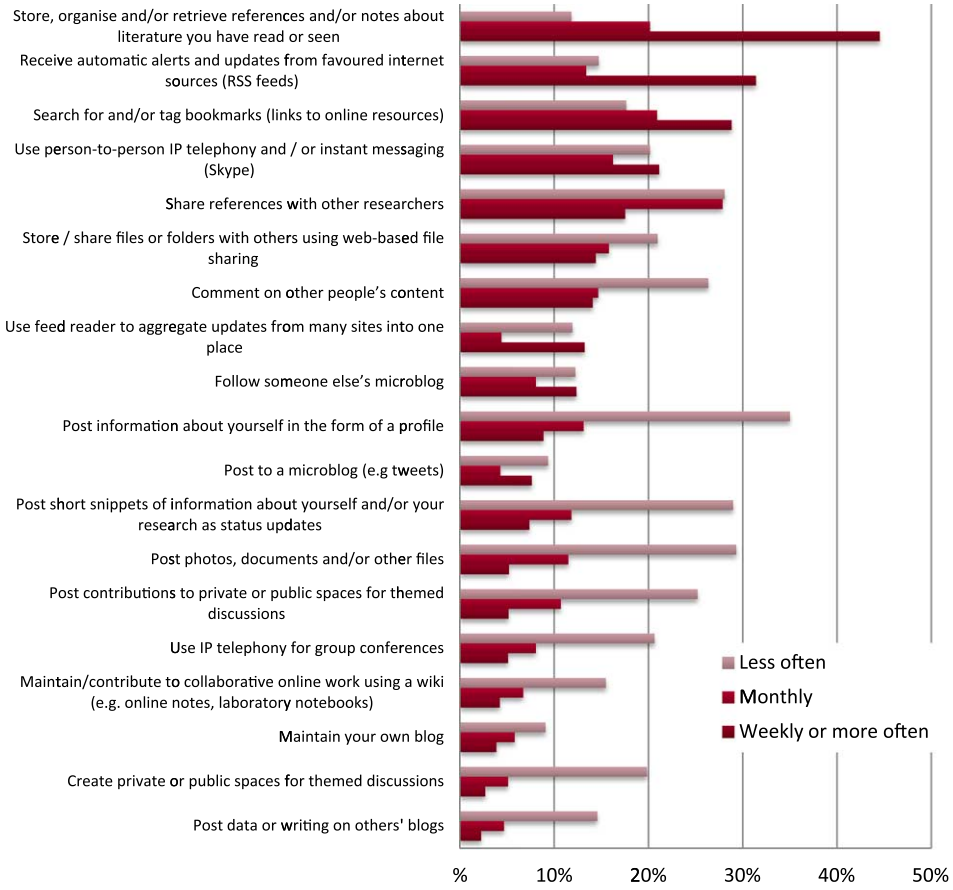

Fig. 5. Use of social media in research work. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/ISU-2012-0637.)

they were nearing the end of their studies.

Of those Generation Y students who had used some kind of technology application provided by their institution, half of them had been influenced to do so by their fellow students and peers, and 40% cited their supervisors as their biggest influence in deciding to take-up a technology tool. They were significantly more likely to act on the suggestions of their peers and their supervisors in this regard than were older doctoral students.

Peers and colleagues were also the most frequently cited influence on those students who made use of some open web technology applications in the previous academic year. In this regard, supervisors, library or technical staff were very much less likely to be the main influence on students' decisions. The majority of the cohort confirmed that their supervisors were not very interested or particularly competent in the latest web technology applications.

The students that used open web technologies received markedly less help in using them overall, from any source, than those using institutionally provided technologies. The large majority had no hands on help with using open web technologies in the previous academic year, and where help was provided by far the most common source was their peers. Similarly, few members of the cohort seemed to have received any significant help or support from their institutions in using any open web technology tools, but

neither did they appear to feel the lack of such support in terms of their own competence. They too relied on their peers to fill any gaps. This lack of institutional support, however, seemed to reinforce the cohort students' own feelings that using open web technologies and online forums in research somehow lacked legitimacy, or that the value and quality of contributions through such forums may be questionable.

2.5. Collaborating, sharing and disseminating research

In arts and humanities and social sciences over 90% of the students work on their research alone; and even in the sciences, with the exception of biological, biomedical and veterinary sciences, the majority of doctoral students also work alone and not in collaborating research teams. The cohort study showed that young doctoral students could become increasingly isolated when they were working alone on their research topic. Although isolation was generally accepted as part of the doctoral studies effect, the importance of social contacts, exchange of information and discussion with other doctoral students was continually mentioned in the cohort discussions.

The research indicates that the student's choice of main work place – whether institution-based or home-based – had an impact upon networking and other collaborative and support behaviours. For example, more institution-based students made use of informal help and advice in using technology tools in their research, particularly from their peers, supervisors and other academic staff, than did the home-based students. Significantly more of the home-based students had no help at all in using technology.

With regard to disseminating their research results, more older students had produced or intended to produce conference papers, perhaps implying greater personal confidence and experience with their subject matter than Generation Y. It is also noteworthy that significantly more Generation Y than older students had produced or intended to produce articles for open access ejournals. Over the course of three years the survey data show a gradual increase in the percentage of Generation Y students who had or intended to publish their emerging research findings in open access journals: from 28% in 2009, 32% in 2010 and 49% in 2011.

However, as noted above there was widespread lack of understanding and uncertainty among doctoral students of all ages about the nature of open access. In 2010 doctoral students were asked to comment on any reservations they might have about publishing or disseminating their own research work through open access channels: the main concerns that emerged were:

- Lack of impact factor, status or credibility of open access journals in the eyes of academic colleagues and potential employers;
- Strong preference for peer-reviewed journals, with a general assumption that open access journals are not peer-reviewed;
- Importance of being cited in other publications and the assumed impossibility or difficulty of this with open access;
- Cost to the individual researcher;
- Concern that copyright is not protected in open access journals.

Few Generation Y (or older) doctoral students seemed as yet to be aware of or to be using institutional repositories to make their research outputs available. In 2011 only 12% reported that they had deposited any research outputs in their institutional repository. Over half did not know whether their institution had any policy of encouraging doctoral researchers to deposit material in the repository. Many institutions in the UK have only recently begun to make the use of institutional repositories mandatory for doctoral students and researchers. This move was discussed with the student cohort, whose critical concerns and

perceived constraints (especially relating to deposit of their final theses) appeared to focus on rights issues, such as

- public access to the thesis online may make the individual student liable if copyright were to be infringed, which would not happen if the thesis were merely used for examination purposes and held by the university library in electronic or hard copy;
- this liability might be particularly critical in the case of humanities research in which images and quotations are likely to be embedded in the main text and essential to the argument; and
- students might be inclined to avoid working on certain subjects where copyright was likely to cause greater problems.
- It would be difficult to find a publisher or journal that would be willing to print material that is already freely available online through a repository.

These data on publishing and disseminating research relate to wider concerns expressed strongly by the cohort about sharing their research findings and research data. Several of the cohort students were concerned about, for instance, the confidentiality of their data and modes of working; and that other researchers might not understand their data in the 'right way'. In the 2011 survey students were asked to say whether and how they share different kinds of research outputs. The clear picture emerging from the data (see Fig. 6) is that the majority of Generation Y doctoral students share their research data and outputs only with their peers or work colleagues. Materials that are associated with work in progress,

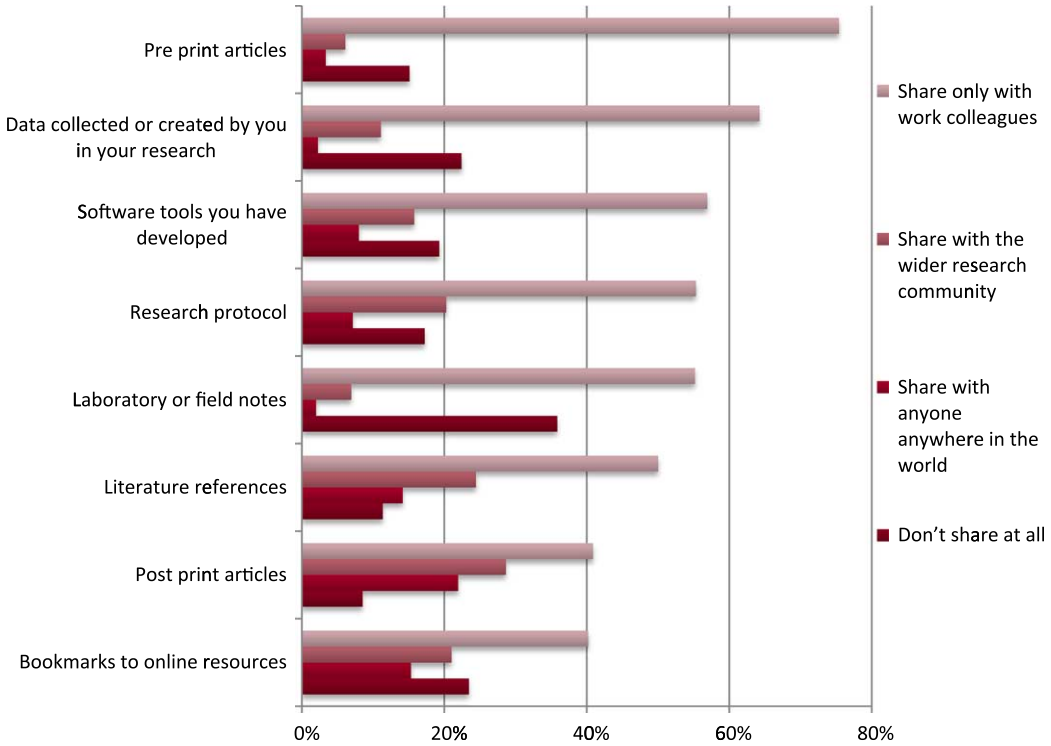

Fig. 6. Research outputs produced and whether shared or not. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/ISU-2012-0637.)

such as laboratory or field notes, bookmarks to online resources and original data, are less likely than finished outputs to be shared at all by doctoral students.

2.6. *Institutional services and facilities to support research*

In 2011 the survey asked the doctoral students to rate in importance the services and facilities provided by their institutions and also to indicate their levels of satisfaction with the same services and facilities using the same ranking (1 not important/not satisfied at all – 5 very important/very satisfied). Figure 7 shows both these overall mean scores and indicates the priority in importance of different institutional services and offers. Unsurprisingly, institutional subscriptions to ejournals in their field was ranked of highest importance overall, closely followed by the knowledge, support and skills of their supervisors.

What is most interesting, however, is the significant gap between relative importance of and relative satisfaction with most of the services and facilities. These data reinforce the messages from other parts of the research: overall satisfaction among doctoral students with, for example, access to institutional

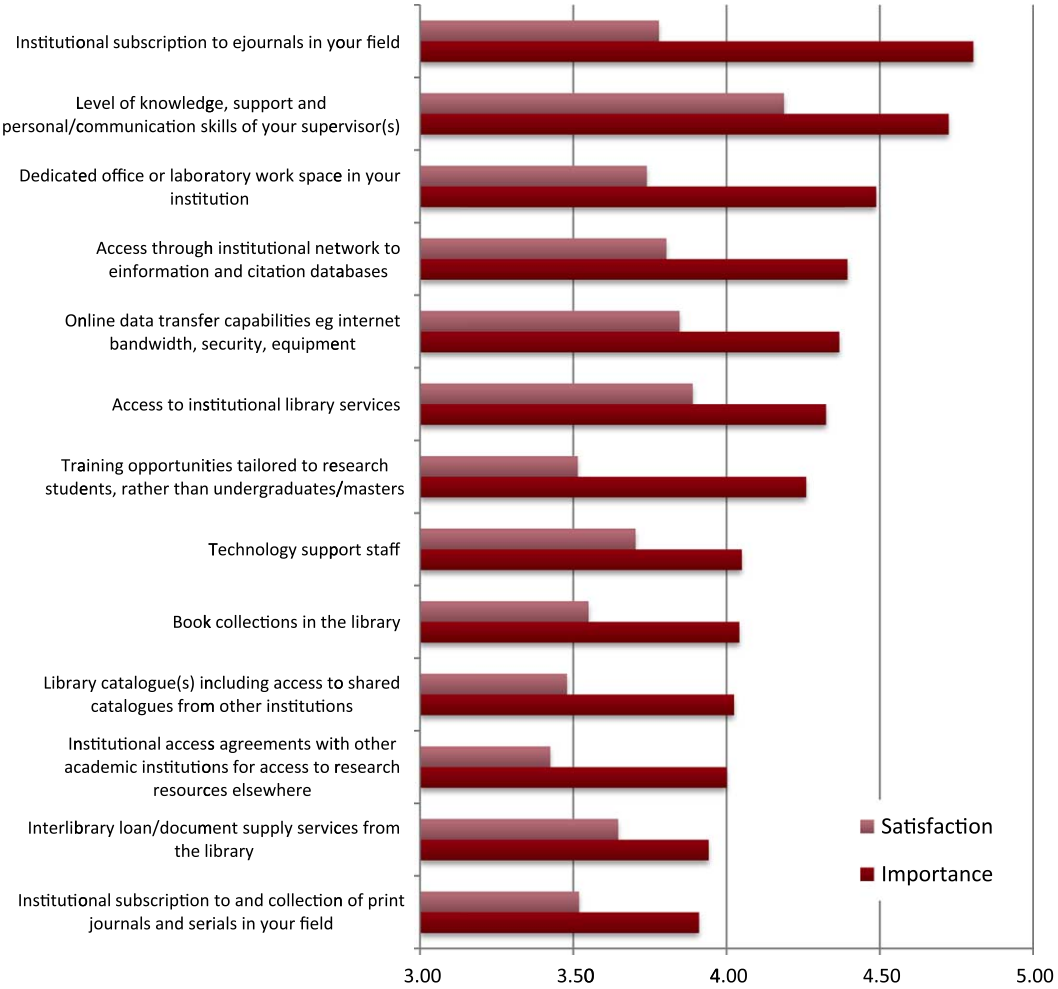

Fig. 7. Importance of institutional services and facilities and satisfaction. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/ISU-2012-0637.)

library services, interlibrary loan services and the knowledge and support of their supervisors is good relative to the importance they attach to them; while satisfaction with, for example, training, subscriptions to ejournals, and institutional access agreements with other academic institutions is not so good relative to their importance.

3. Conclusions

The *Researchers of Tomorrow* study showed that Generation Y doctoral students are sophisticated information-seekers and users of complex information sources, who are not dazzled by technology and who are acutely aware of critical issues such as authority and authenticity in research and evidence-gathering.

3.1. Secondary and primary research resources

Among all doctoral students, including Generation Y, there is a striking dependence on secondary published research resources; the study findings suggest that, as the basis for their own analytical and original research, very few doctoral students in social sciences and arts and humanities are using 'primary' materials such as newspapers, archival material, images, artefacts, social data; and in sciences, few are drawing on large datasets (not specifically linked to pre-published research). These indicative findings need to be validated, as the implications are so significant. There is a strong case for more in-depth research among doctoral students to determine whether these data signal a real shift away from doctoral research based on primary sources compared to, say, a decade ago. If this proves to be the case there may be significant implications for doctoral research quality related to what Park described as "widely articulated tensions between product (producing a thesis of adequate quality) and process (developing the researcher), and between timely completion and high quality research" [3]. There may also be other long-term concerns, such as what this might mean for the concept of the doctorate as a 'research apprenticeship', if it includes little experience of finding and using non-published and 'primary' research sources and materials in research work.

3.2. The scholarly information environment

Given their apparently heavy dependence on published research sources, the Generation Y doctoral students' overall lack of understanding about how the networked information and scholarly communications environment functions seems of significant concern. At the institutional level, the authentication of access to and licensing limitations on subscription-based resources, and the impact of different access agreements with commercial suppliers and other institutions are generally perplexing and often frustrating for doctoral students. In the web-based environment, doctoral students can be prevented from legitimately widening the scope of their research using open access research resources by a number of factors that include widespread misconceptions about concepts such as open access, self-archiving, copyright and IPR, and the current citation-based assessment and authenticity criteria in doctoral and academic research that discourage citing non-published or original material, such as web-based data, as research evidence in doctoral theses.

The question arises whether doctoral students properly supported and equipped at institutional level to navigate their way through this environment successfully. Should institutions try harder to ensure that the gaps in doctoral students' understanding of their research information environment are addressed more

effectively and earlier in their postgraduate career, so that their expectations of institutional provision are more realistic?

More widely, are the mechanisms of 'authority' and 'legitimacy' of research resources (such as peer review, citation, publisher/origin etc.) still valid and adequate to help doctoral students make choices, and might these be widened to include, for example, the allowable citation of web-based datasets?

3.3. Technology take-up and use

Contrary to expectations, Generation Y doctoral students tend *not* to be early adopters and keen users of the latest technology applications and tools in their research. Though they are highly competent and skilled in using ICT in general, in their research work they tend to be quite risk averse and 'behind the curve' in using technology. The possible reasons for the relatively low take-up of many technologies among Generation Y doctoral students are several: the technologies on offer in institutions may not always be appropriate to needs (e.g. lock-in to proprietary systems); some new tools and applications challenge existing, traditional and conservative doctoral research practices; and institutions' methods of engaging with doctoral students to demonstrate the potential benefits of using technology may lag behind individual interests and competences and be ineffective.

3.4. Collaborating, sharing and disseminating research

Despite international trends towards greater collaboration in research (with industry, across international borders, etc.), Generation Y doctoral students appear to be constrained by their own lack of confidence in their research work, the need for doctoral students to demonstrate originality in research findings and their supervisors' ambivalent attitudes towards greater openness and sharing.

There may be great value for doctoral students in being more open, in communicating and contributing within wider research networks (e.g. in terms of overcoming personal isolation, not reinventing the wheel in information seeking, sharing new and innovative resources that open up research topics and questions etc.). Social media and file-sharing applications offer opportunities to do this, but the benefits of using social media to communicate, collaborate and share do not fit with their current research status: technology take-up among Generation Y doctoral students follows clear perception of value and use within current working practices. Greater sharing and openness, and collaboration outside of an institutional research group, challenge the accepted working practices in the current doctoral model.

The question arises whether, in the light of international research trends, there is any higher education sector or institutional commitment to accepting the changes in the current doctoral research model implied by greater openness and sharing?

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