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6 Interdisciplinarity and Permeable Boundaries

The second of Boyer's scholarly functions was that of integration, which he described as 'making connections across the disciplines, placing the specialties in larger context, illuminating data in a revealing way, often educating non-specialists'. In this chapter we will look at one aspect of this, interdisciplinarity, and the possible impact of new technologies on the boundaries between disciplines.

Interdisciplinarity

The cross-fertilisation of knowledge from different disciplines has a long history. Indeed, much of history was dominated by the pursuit of unified knowledge, a broad definition and approach to science and the pursuit of knowledge, a *Wissenschaft*, and the differentiation of knowledge into separate disciplines was seen as problematic. However, in order to progress knowledge in ever-more complex fields, specialisation became inevitable and productive. Simultaneously there was an acknowledgement that the application of knowledge across domains was also fruitful and should be actively encouraged. This can lead to a rather schizophrenic attitude towards interdisciplinarity – it is seen as both essential and yet not as pure as disciplinary study. As Klein (1991) puts it, 'interdisciplinarity has been described as both nostalgia for lost wholeness and a new stage in the evolution of science'.

Moti (1995) provides a useful definition of 'bringing together in some fashion distinctive components of two or more disciplines' and suggests that there are four 'realms' of interdisciplinarity:

- 1 interdisciplinary knowledge – familiarity with distinctive knowledge of two or more disciplines;
- 2 interdisciplinary research – combining approaches from two or more disciplines while searching or creating new knowledge;
- 3 interdisciplinary education – merging knowledge from two or more disciplines in a single programme of instruction; and
- 4 interdisciplinary theory – takes interdisciplinary knowledge, research or education as its main objects of study.

Interdisciplinarity has seen something of a revival of interest recently partly in recognition that many of the substantial challenges facing society will not be solved by a single disciplinary approach, including climate change, dwindling resources, global health epidemics and the impact of global information networks. Indeed the globalisation of many issues, often driven by the Internet, can be seen as an impetus for interdisciplinarity. Kockelmans (1979) summarises that there is an 'inexorable logic that the real problems of society do not come in discipline-shaped blocks'.

However, even with an agreement that interdisciplinary approaches are necessary for the solution of some problems, it is not always easy to achieve. C.P. Snow (1960) famously decried the two cultures' division of arts and science; yet the cultural differences can be seen as even finer grained than this broad binary division. There are differences in disciplines and even sub-disciplines, in terms of how research is performed, what constitutes valuable knowledge, approaches to collaboration and what form dissemination should take. For instance, in many 'hard science' disciplines, work is performed by large teams, and the conference publication is seen as a primary means of dissemination, whereas in the humanities work is often performed by the lone scholar, researching in archives and publishing in journals. Overcoming many of these explicit and implicit differences is one of the challenges of interdisciplinarity. It is by no means an easy task as Bauer (1990) suggests:

Interdisciplinary work is intractable because the search for knowledge in different fields entails different interests, and thereby different values too; and the different possibilities of knowledge about different subjects also lead to different epistemologies.

Thus differences among practitioners of the various disciplines are pervasive and aptly described as cultural ones, and interdisciplinary work requires transcending unconscious habits of thought.

Some of the barriers to interdisciplinarity can be seen in Chapter 5; for example, journals tend to be disciplinary in nature, and publication in such journals is closely allied with promotion and tenure. The prestigious journals tend to be strongly disciplinary, and research communities have views regarding quality outputs and research which are either expressed indirectly or reinforced directly through exercises such as the REF (Conole *et al.* 2010). So while there are calls for interdisciplinary work to tackle some of the 'big problems', the culture created in higher education and research works against this.

What we are concerned with here is the role that technology, and in particular an open, digital, networked approach, can play in interdisciplinarity. Roco and Bainbridge (2003) argue very positively for the role of technology, suggesting there is a convergence occurring in science as a result of three developments: scientific

knowledge now being applicable from the nano- to the macro-scale, technology and suitable methodology. Hendler *et al.* (2008), however, propose that the study of the technology itself should be an interdisciplinary field, what they term 'web science'.

Some of the barriers to interdisciplinarity may be attributable to the different cultures which have arisen in disciplines, but there is also an economic aspect – interdisciplinary work is often not profitable to engage in. If one considers interdisciplinary study as the intersection of two separate disciplines, then that intersection is likely to be less than either discipline in terms of interested audience. The interdisciplinary journals which do exist need to be very specific in the areas of intersection they address; in short, they need to have an identifiable market. However, much of the positive benefit of interdisciplinarity can arise from the unexpected collision of distinct areas of study. This unpredictability is an area that current economics of practice is not structured to capture or encourage, as it are often grounded in the limitations of physical constraints. Journals need to have an identified market to interest publishers, people need to be situated within a physical department in a university, books are placed on certain shelves in book shops. Digital classification of books allows them to occupy many 'shelves' simultaneously, but even more relevant the low, or zero, cost associated with other forms of digital outputs means they can be produced without the need for identifying a particular audience, and once produced, because they are easily shareable, they can be used in unpredicted contexts or combined with dissonant material. This is an aspect we will look at in more detail in Chapter 7.

The potential of technology

The potential of new technologies to encourage interdisciplinarity may be greater than their use in research, which was addressed in Chapter 5. Because interdisciplinary work is often not well represented by the existing funding and publishing environment, it is also not subject to the restrictions this places on practice and innovation. The lightweight and unrestricted forms of communication found in many Web 2.0 tools may serve the needs of interdisciplinarity to overcome existing disciplinary and geographical boundaries (Anderson 2007).

Taking blogs as an example Aemeur, Brassard and Paquet (2005) suggest they act as a form of personal knowledge publishing which fosters interdisciplinary knowledge sharing.

An interesting, but as yet probably unanswerable, question is, to what extent do the new technologies and associated practices create a common set of values, epistemological approaches and communication methods? That is, do the cultural norms associated with the use of the new technologies override those of the separate disciplines? Obviously there is nothing inherent in the technologies

themselves that force users to behave in a specific manner; for example, one could use Twitter to simply repeat the same sentence every day. But *successful* use of the technologies often requires the adoption of certain approaches or cultural norms, whether it is deliberate or not.

Continuing with the example of blogging, regardless of the subject matter of a particular blog or the informal community to which that blog may belong to, there are some persistent cultural norms. Shaohui and Lihua (2008) suggest the following three characteristics of blog culture:

- 1 Thought share – if the first generation of websites were characterised by information sharing, then blogs mark a move to sharing thoughts.
- 2 Nonlinearity and concentricity – through linking, embedding, within blogs and then aggregation of blogs, there is a nonlinear construction of knowledge.
- 3 Criticalness and multivariate collision – specifically this arises from a personal, subjective standpoint that attracts varied comments and views.

The blogger and entrepreneur Loic Le Meur (2005) suggested a number of aspects of a blog community, including

- a willingness to share thoughts and experiences with others at an early stage;
- the importance of getting input from others on an idea or opinion;
- launching collaborative projects that would be very difficult or impossible to achieve alone;
- gathering information from a high number of sources every day;
- control over the sources and aggregation of their news;
- the existence of a 'common code': a vocabulary, a way to write posts and behaviour codes such as quoting other sources when you use them, linking into them, commenting on other posts and so on;
- a culture of speed and currency, with a preference to post or react instantaneously; and
- a need for recognition – bloggers want to express themselves and get credit for it.

By becoming a blogger then, one begins to adopt these practices, because they make for a successful blog, and they are represented in the blogs that constitute the cultural norms. Ehrlich and Levin (2005) state that 'norms and metanorms provide

a cultural stickiness or viscosity that can help sustain adaptive behaviour and retard detrimental changes, but that equally can inhibit the introduction and spread of beneficial ones'. The cultural stickiness of the blogging community then is to share ideas, link and acknowledge others, gather and share information quickly, and operate in a timely manner. These could also be presented as attributes which can be seen to serve the needs of interdisciplinarity.

Precisely because it is relatively new, there has been a good deal of interdisciplinarity in the blogosphere. Although many bloggers will tend to read the blogs within their subject area, they will also come across those of overlapping or even distinct disciplines. But also *within* any given blog there is an element of interdisciplinarity or at least variety. Because blogs operate at the intersection of personal and professional life, unlike a journal, their content is not bounded by discipline. While a blogger may post predominantly on a particular subject (say 'Open Science') they may also have an interest in other areas, for example, Haikus and Japanese poetry, which they will bring into their posts, precisely because this personal mix is what renders blogs interesting. Open Science and Haikus would not be a combination one is likely to find in a conventional journal, but when the publishing filter is removed, and the community norms promote an element of personal interest, then this kind of mix arises. For example, one of my favourite blogs is Jim Groom's *Bavatuesdays*, which mixes thoughts on educational technology and advice on the blogging platform Wordpress with meditations on B-horror films. The mix seems perfectly logical and acceptable within the norms of the blogging community.

This may not constitute interdisciplinarity in an academic sense, but we can see interdisciplinary knowledge arising in at least four ways in blogs:

- 1 as the formal communication platform of a department, project or individual with a specific interdisciplinary remit;
- 2 through the historical context of the individual, who may have specialised in a different domain previously and can reference this in a personal blog;
- 3 informal interests which overlap with the more substantive content of the blog, such as the examples above; and
- 4 through comments and links from the blogs' wider readership.

Each of these routes for interdisciplinarity would be difficult to realise through the more formal mechanisms of journals or conferences.

What is potentially significant for interdisciplinarity then is not so much the technology itself but the practices that are associated with it. This is particularly relevant with regard to openness.

Twitter as interdisciplinary network

Blogs provide a good example of how interdisciplinary knowledge can be disseminated.

Another example is the social network, which potentially allows for connections between people and content across disciplines. I will take Twitter as the example for a social network here to explore this, although it could be applied to other tools equally well.

First, some history on Twitter as it is pertinent to how it can act as a tool for interdisciplinarity. Developed in 2006 when their initial podcasting company Odeo was floundering, Twitter focused around status-type updates delivered via mobile phone. This focus on being able to text was the reason for the 140 character limit, and the initial prompt was to answer the question 'What are you doing?' People could follow others, so it provided a means of broadcasting a message to all friends.

It was launched into the mainstream in 2007 and was a big success at the influential SXSW conference that year. One of the key elements in its success has been its open API, which allowed other developers to build applications using the Twitter data. This meant that people didn't need to even visit the Twitter website to use it; they could instead use one of the many different clients. This open API approach has seen unpredictable and wide-ranging uses of Twitter, including use as a public log for activities such as running and weight loss, picture sharing services, data analysis, news and market trend monitoring, management of Twitter network, link shortening, archiving tweets, polling and so on.

Although Twitter is not open source, this open approach in terms of how people access it and what they use it for has allowed the network to grow and make it a default network for many different groups of people.

Three key features of Twitter demonstrate how an open approach has allowed community norms to emerge. The first is the convention of putting an @ sign in front of a person's Twitter ID to send them a reply (e.g. @mweller). This was a user convention first of all, so it would designate that a particular tweet was for the attention of a particular user. As Twitter developed it became a standard convention, and then incorporated into the software, so now users can see all replies to them listed separately. The @ reply rule grew out of the email naming convention but has almost become synonymous with Twitter now.

The second convention was the use of hashtags to define a particular comment which could be grouped together. The use of the # was proposed by Chris Messina in a tweet: 'how do you feel about using # (pound) for groups. As in #barcamp [msg]?' Hashtags can be seen as metadata, describing the content of a tweet. They became relevant as the use of search on Twitter grew. People could search on a hashtag and thus gather all of the tweets on a particular topic. This was seized on by conferences, so all the delegates at a conference would agree to use a hashtag,

and later conference organisers began specifying an official hashtag. Search was originally performed by a third-party service (using the open API), but in July 2008, Twitter bought Summize, the most popular Twitter search tool. Hashtags could now be incorporated into standard Twitter practice, and ‘trending’ became a relevant term as topics grew on Twitter, often denoted by a hashtag. Apparently the Twitter team initially rejected hashtags as ‘too nerdy’ (Gannes 2010), but their simple, and unregulated, creation has allowed them to flourish.

Hashtags can now be used as the means to define a community, particularly around an event, course or topic. The open data approach of Twitter means that these can in turn be analysed to reveal connections between members, subjects of discussion, locations and prominent members (e.g. Hirst 2010). As well as a useful means of categorising tweets, hashtags are now so ingrained in practice that they form a part of humour on Twitter, with people often creating ‘mock’ hashtags (although there are no official hashtags) as an ironic counterpoint.

The third norm to emerge is that of the retweet. This is the practice of passing on someone’s tweet. Originally, this was achieved by copying and pasting the tweet and adding RT and the user’s ID at the start. Boyd, Golder and Lotan (2010) identify the following motivations for retweeting:

- to amplify or spread tweets to new audiences;
- to entertain or inform a specific audience, or as an act of curation;
- to comment on someone’s tweet by retweeting and adding new content, often to begin a conversation;
- to make one’s presence as a listener visible;
- to publicly agree with someone;
- to validate others’ thoughts;
- as an act of friendship, loyalty or homage by drawing attention, sometimes via a retweet request;
- to recognise or refer to less popular people or less visible content;
- for self-gain, either to gain followers or reciprocity from more visible participants; and
- to save tweets for future personal access.

As with the other community behaviours, the retweet became enshrined in code, when in late 2009 Twitter implemented a retweet function on its site. This allowed users to easily retweet a message by simply clicking a button, without the need for

copy and paste, but some of the subtlety as to how it appears in timelines was lost (it is shown coming from the originator and not the retweeter).

What these three examples demonstrate is that the community has evolved over time, suggesting, experimenting and then adopting norms of behaviour – the ‘stickiness’ we saw with blog culture. Once it has become established, and proven to add value, Twitter has then moved to implement it in code to make it easier and also to further spread its use. It has not imposed the practice from the start, and sought to define how users will interact, which has often been the case with software development; instead it has allowed the community itself to develop its own norms.

If I analyse my own Twitter network (using the free service TwitterAnalyzer.com) it reveals that the geographic spread of my followers is mainly across the following countries: United Kingdom, United States, Australia, Germany, Canada, France and China.

By analysing the biography details people provide the top professions amongst my followers are consultant, technologist, PhD student, lecturer, manager, teacher, librarian and author.

Amongst these I can identify a number of communities and networks, some of which will intersect. These include the following:

- Bloggers – many of the people I follow are those I already had an online connection with via blogs, and Twitter was an extension of this.
- The Open University – I have acted as an advocate for Twitter in the Open University and see it as a means of knowledge sharing within an organisation.
- Cardiff – I live in Cardiff, Wales, and there is an active Twitter community, which often meets face to face.
- UK Higher Education – As well as bloggers and Open University people there is a large contingent of peers in other universities, funding bodies, libraries and so on.
- Journalists and media – a number of journalists and media consultants use Twitter regularly.
- Tottenham Hotspur – I support Spurs and a number of people I follow for this reason, but also there is a wider group for whom football is an interest (who are also members of the other networks).

There are a number of subgroups in this also; for example, Canadian bloggers form a coherent network of their own, and many individuals will occupy more than

one category. One can view these many different groups and subgroups as networks that will become more or less active, and distinct, according to external events. For example, during the general election in the United Kingdom, this geographic grouping became more significant because there was a unifying theme. This is seen particularly with large, synchronous events such as the televised debates during the election.

Huberman, Romero and Wu (2009) have investigated interactions on Twitter and find that despite many followers the number of people a user interacts with (i.e. sends replies to) is relatively small. This reflects findings in Facebook and is interpreted as the existence of Dunbar's number (1992), as mentioned in Chapter 1, in social networks. While this may well be true for the more stable relationships, the use of functions such as hashtags and retweets allows for a finer grading of online acquaintance. I can read, or retweet, someone else's posts without ever interacting with them, and they may reciprocate, without engaging in direct conversation; yet these people form part of a valuable network.

As an interdisciplinary tool the Twitter network has a number of advantages and associated issues.

Geographical diversity – while my network is inevitably centred on the United Kingdom and North America, it is a global community which brings together different perspectives. It is limited by language though, and the immediacy does not allow for translation, so there is a danger of English language views dominating.

Professional diversity – within the different networks a range of professions and experience can be found, which will inevitably bring a degree of interdisciplinarity. One of the benefits of Twitter has been to improve interdepartmental communication within an institution. However, while the list above shows a reasonable range of occupations, it is still largely centred on higher education. There are, for example, very few (or no) priests, builders, make-up artists or senior retail managers in my network (which is not to say they are not present on Twitter). For interdisciplinarity this may not be an issue.

Size – at the time of writing I follow about 1,100 people and have approximately 3,400 followers. That represents a considerable network and pool of expertise which will share a wide range of knowledge and will also respond to requests for advice on topics outside of my own domain.

Immediacy – one of the changes Twitter required in my behaviour was a shift from exhaustive reading to regular sampling. As a blog reader I tried to keep up with most posts from those I subscribed to, with subsequent guilt when the unread count on my blog reader mounted. As my Twitter network expanded this behaviour was not possible and so a shift was required, which means I 'dip into' Twitter, sometimes more intensively and other times I am completely absent. This is the

concept of the stream; it is not meant to be consumed in its entirety but sampled on occasion. Twitterers are responding in real time, and thus it is ideal for capturing diverse reactions and interpretations before they are filtered into disciplines. There is a consequent danger though that this relentless churning of information means useful research will be missed via this route.

Interdisciplinary bridges – the ease of sharing provides a means to bridge disciplines, in particular the retweet can be viewed as a tool for bridging audiences and disciplines as a twitterer in one domain can rebroadcast to their network, which will have the types of subgroupings shown above.

An inherent set of cultural norms – the three features we saw above, as well as other practices, indicate that, as with blogs, Twitter has its own set of cultural norms, which provide the required ‘stickiness’ for communities to develop. These may be sufficient to overcome the differences in cultural norms across disciplines and provide a common framework.

Professional and personal mix – Twitter occupies an intersection between professional and personal, formal and informal, and resource and conversation. In many previous tools we have sought to separate out these elements; for instance, when we create forums for students in VLEs it is a common practice to have a separate ‘Chat’ or social forum so that this doesn’t interfere with the academic discussion. However, this blend in one place in Twitter both provides motivation to partake (we don’t separate out our thoughts or lives so neatly) and also provides hooks into other areas of interdisciplinarity.

One of the reservations regarding Twitter, and other forms of online community tools, is the possibility of an echo chamber, which is the antithesis of what is desired for interdisciplinarity. As the amount of information available increases, there is an argument that it becomes more difficult to hear distinct and different voices. This occurs for two reasons: first, there is so much information arising from your immediate area of interest that it becomes difficult to keep up with this; second, it is now possible to find a group of like-minded people whatever your interests or tastes, so it is more emotionally ‘comfortable’ to spend time with these rather than with different voices. In a physical setting bounded by geographical constraints, one is more likely to be with a diverse group of people, but online the pool of people is larger so the grouping is more likely to be around interests and tastes than convenience or location. This is beneficial for many things; working with like-minded people often leads to quick development, but for interdisciplinarity it may create new types of boundaries. One can create a distorted view of what is a general consensus because dissenting voices are not heard. Of course, this is equally true (if not more so) with controlled media who will reflect certain positions.

The solution to the potential for the echo chamber to arise is to cultivate networks with a reasonable level of diversity and follow people who share diverse resources. It is not necessary to go to extremes in this for interdisciplinarity to be fostered but simply to ensure that there are some people who are in other disciplines and those who are in roles that cross boundaries.

The list above shows a number of benefits in developing a networked approach to interdisciplinarity, which may address the issues which have plagued it for many years. Indeed if researchers had intentionally set out to create a tool for promoting interdisciplinary discourse, then the resultant service may have not looked dissimilar to Twitter.

Conclusion

One way of approaching Boyer's category of integration is to consider the combination of different academic disciplines. While interdisciplinarity is seen as a necessary approach to solve many of the complex real-world problems, some of the cultural practices in research create obstacles to its realisation. In this chapter the possible role of two technologies to address this was explored, namely blogs and Twitter (as an example of a social network). In both cases there exist strong cultural norms of their own, which may address some of the cultural barriers within disciplines by providing a common set of values, so it may be that bloggers in different disciplines are more alike than non-bloggers and bloggers within the same discipline. Similarly, the history and approach of Twitter have been one of allowing community norms to develop and then reinforcing these through software implementation. The result is a tool with features and associated practice which can positively encourage interdisciplinarity. In both cases it is the cultural norms that have developed around the tools rather than being determined by the technology.

If we return to Moti's (1995) four realms of interdisciplinarity, we can consider how such approaches can be used to address them:

- 1 Interdisciplinary knowledge – the easy and varied publication in blogs creates less rigid boundaries between disciplines and allows for unpredictable interactions.
- 2 Interdisciplinary research – using social networks, loosely coupled teams across different disciplines can provide input to research.
- 3 Interdisciplinary education – the proliferation of free, open content means that courses can be created by collecting resources from a range of disciplines, and these resources are easily discoverable through search and network recommendations.

- 4 Interdisciplinary theory – the development of the previous three approaches can lead to a richer and broader study of interdisciplinarity, and using different dissemination methods, this work can be applied to diverse areas.

What underlies much of the potential for new tools to enhance interdisciplinarity is the easy, cheap and unfiltered production of content which can be shared effectively, which is also a factor in realising public engagement, which is the subject of Chapter 7.