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Cyberscience 2.0

Research in the Age of Digital Social Networks

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Contents

Preface

This book is the result of the research carried out by the two authors between 2008 and 2011 in the framework of the project "Interactive Science. Internal Science Communication via Digital Media", funded by the German Volkswagen Foundation under its program "Key Issues in the Humanities" (project number II/83099). In this joint project, led by the Center for Interactive Media (ZMI) of the University of Gießen, four subprojects explored the theme from various angles. The authors formed the Vienna-based team at the Institute of Technology Assessment (ITA) of the Austrian Academy of Sciences within the sub-project "Collaborative Knowledge Management and Democratization of Science". We focused on several emerging promising Internet platforms that potentially have an impact on science and research. Our initial plan to write a series of short portraits of many of these tools quickly evolved into a much more challenging task. We felt the need to deliver more in-depth presentations and preliminary analyses of our case studies: social network sites, microblogging, collaborative knowledge production platforms, virtual worlds, and search engines. For the present book, we have built on these five reports (in German) and extended the analysis by comparing these tools and drawing meta-level conclusions.

Very special thanks go to *Ernest Braun*, the first technology assessor in Austria and founder of ITA in 1988, emeritus professor of physics and technology policy at the University of Aston in Birmingham. He accompanied the genesis of this book over the last months and invested a great deal of effort into this manuscript, both on the level of language and by raising critical questions to us. It was challenging and fruitful to have Ernest on board who cannot be accused of being a computer addict and Web 2.0 aficionado.

Furthermore, we are very grateful to our colleagues in the overall project for their feedback and input over time, in particular to *Christoph Bieber,*

Gerd Fritz, Thomas Gloning, Claus Leggewie, Henning Lobin, Sibylle Peters, and *Jan Schmirmund*. We also gladly acknowledge the major input by *Jana Herwig* and *Axel Kittenberger* to our interim report on microblogging, which was the basis for section 2.2. In addition, special thanks go to *Walter Peissl, Stefan Strauß, Georg Aichholzer, Cornelius Puschmann, Peter Haber, Ulrich Riehm, Astrid Mager, Ellen Fischer,* and *Karen Kastenhofer* for commenting on some parts of the manuscript, but we certainly take the responsibility for the final text and its remaining shortcomings. Many thanks also go out to our interview partners and all the others who took their time to answer our questions, in particular *Payal Arora* who helped us with many details. We are indebted to the Institute of Technology Assessment and Systems Analysis (ITAS) in Karlsruhe for making it possible for one of us to concentrate fully on this text for several months, while the other had to split his attention between this book and his managerial tasks related to ITA, which has undergone an important external evaluation and was affected by a major institutional crisis of its mother institution, right during the hot phase of finalizing this text. Michael sends his thanks also to the students of his recent seminars on cyberscience at the University of Vienna who inspired him with challenging questions. René would like to express special thanks to his colleagues at ITAS, in particular the "421 bike crew", for their warm and helpful welcome and working environment. Last, but not least, we gratefully acknowledge the support of the Campus team, which handled the production process in a very professional and amiable manner.

Michael Nentwich
René König
Vienna/Karlsruhe, December 2011

1 Introduction

In the early part of the 21st century one of us coined the term "cyberscience" (Nentwich 2003) to describe the trend of applying information and communication technologies (ICT) to scientific research. Scholars tended increasingly to use the Internet not only to exchange e-mails, but also to participate in online debates, cooperate at distance, use remote databases, simulate and model reality on their computers, and teaching their students with the web. These developments have not come to a halt since the early days but have accelerated and diversified ever since. As will be discussed in section 1.1, the Internet has today become an essential tool for everyday scholarly communication; academic work without the use of the Internet is now as unthinkable as writing an academic paper on a typewriter, especially for young researchers. The emergence of Web 2.0 opened up new opportunities, seized not only by the general Internet community worldwide, but increasingly also by researchers and academic teachers. During the same period powerful commercial actors continued the development of the Internet and made it a different place compared to its early days.

This book focuses on these latest trends and addresses two interrelated research questions: *What role does the digital social culture triggered by Web 2.0 play in the academic world at present and what are the potentials of platforms such as Twitter, Facebook, and Wikipedia? What impact will the emerging socio-technical practices have?*

We approach an answer to these questions in three steps. First, we will review the status quo of how cyberscience developed (1.1) and which new tools and platforms evolved over the last decade with the potential to serve the academic communities (1.2); as a basis for our empirical research and subsequent analysis, we will present our conceptual framework (1.3). Second, we will present five empirical case studies, discussing promising fields of the developments in recent years when it comes to analyze the potential

impact on academia: social network sites such as Facebook and similar sites specifically dedicated to research communities (2.1); microblogging with a focus on Twitter (2.2); collaborative knowledge resources, exemplified by various projects of the Wikimedia foundation, namely Wikipedia, Wikibooks, and Wikiversity (2.3); virtual worlds, in particular the rise and fall of Second Life (2.4); finally the most prominent and ubiquitously used universal search engine Google Web Search as well as Google Scholar and Google Books, which are of special interest for academia (2.5). In a third step, we will analyze the empirical material of chapter 2 in the light of our conceptual framework identifying the following key issues: the crucial role of interactivity (3.1); the blurring boundary between academia and the public (3.2); academic quality in the age of Web 2.0 (3.3); the problem of multiple channels and information overload (3.4); transparency and privacy (3.5); and finally potentially democratizing effects emerging from the participatory possibilities of the new platforms (3.6). The book closes with an outlook and overall conclusions, in which we put the analyzed developments into perspective (4.)

1.1 Cyberscience 1.0 Revisited

The notion of cyberscience first appeared in the literature fifteen years ago (Wouters 1996; Thagard 1997); it was later conceptualized and defined "as scientific activities taking place in the information and communication space that is coming into existence with the help of information and communication technologies, a space in which scientists increasingly circulate while remaining at their desks" (Nentwich 1999, transl.). The study *Cyberscience: Research in the Age of the Internet* (Nentwich 2003) demonstrated empirically and analytically, in detail way, that (1) the transition from traditional science to cyberscience has the potential to bring about changes in all dimensions of scientific activity, including organizational space, and that (2) the changes in science that are occurring in this way are qualitative in nature. At that time, the main focus of the analysis was still on the transition to an electronic publication system (e-journals, multimedia, hypertext, quality control, and digital libraries) and on Internet-based forms of communication and cooperation (e-mail, electronic conferences, groupware, virtual institutes, collaboratories). Even by then, though, it was clear that

this object of research was a moving target; today, hardly a day goes by without the appearance of new e-journals, innovative forms of cyber-cooperation, and novel Internet tools and services, all of which at least have the potential to change the way in which scientists work—this dynamic character of the field is one of the main reasons for writing this book. Before looking in more detail at the latest Web 2.0 related developments (below 1.2), we give a brief overview of the status quo of the maturing cyberscience.

One of the most visible impacts of the evolution of cyberscience relates to the *scholarly publication* system. Academic publishing is not what it used to be before the advent of the Internet: In most fields, electronic journals emerged, the publishing houses offer their paper journals also online, huge digital working paper archives give access to the research literature at an early stage, and research libraries slowly turn into "cybraries" (Okerson 1997) providing access to digital repositories of all sorts. Furthermore, we can observe new forms of scholarly publications that would not have been possible in the traditional paper environment, but can only be realized in digital formats. While genuine (strong) hypertexts, which would present knowledge differently, are not frequent, the weak form of electronic texts with multiple links becomes the norm. In enhanced versions of journal articles, multimedia elements like small video clips enhance the ways to convey messages to the reader; and communicating research results via (annotated) databases becomes ever more common (Hey and Trefethen 2008, 16). Since 2003, the open access movement has gained in strength and challenges the commercial scholarly publishing system. Today, an estimated 20 to 25 percent (Björk et al. 2009; Björk et al. 2010; Gargouri et al. 2010) of all research literature in journals is available online *and* open access.

Nowadays by far the most usual form of *direct communication* between researchers is via e-mail, almost universally replacing traditional mail. Voice-over-IP services, such as Skype, have taken over traditional phone calls in some fields. By contrast, video conferencing in academia is still in its infancy, only a few research communities such as high-energy physicists use them more frequently. One of the reasons is that the technical equipment and bandwidth necessary to achieve good quality is generally not available or very expensive, which is a problem in most fields of research. Chatting seems to be a communication channel used by the younger generation of

researchers and often as a side-channel to the audio-video conferencing software Skype or within a social network site (see below).

Software supporting *collaboration of groups at a distance*, often subsumed under the umbrella term "groupware", have not yet "taken off", so-called "collaboratories" (Olson et al. 2008) or virtual institutes are not the norm. Most project groups or co-authors still use e-mail as their main tool for exchanging files, only few started to use wikis or other platforms—despite their abundant availability.

The *methods of research* are increasingly influenced by the use of ICT. In some fields, such as astronomy, climate and pharmaceutical research, distributed computing, i.e. the organized use of a large number of computers distributed worldwide to perform computational tasks too expensive or even too large for supercomputers, is widespread. In the social sciences Internet surveys have become an important tool for empirical research and increasingly so even for topics that are not directly connected to the Internet use per se. Research databases, stored not locally, but on the web, are a popular tool. In general, novel methods relying on ICT are developed and often referred to as "digital humanities" or "digital methods".

When it comes to *teaching*, many universities nowadays provide e-learning platforms to administer classes, communicate with the students and exchange files and other resources. Many also broadcast their lectures online, making them available at any time to a larger audience. However, distant learning is far from replacing traditional face-to-face methods on a macro level.

To sum up, since the turn of the millennium, cyberscience matured and is now ubiquitous. Practically all researchers of most fields are cyberscientists as they spend a considerable and increasing amount of time not only in front of a computer screen, but also communicating with their objects of research, their peers, and the extra-academic world (Gibbons et al. 1994, 36ff.). In contrast to this, "traditional science" persists only in small niches. There is no doubt we live in the age of cyberscience. But what is next?

1.2 Web 2.0 and Cyberscience

1.2.1 The Internet is becoming a social space

The term Web 2.0 seems to have been used for the first time in a magazine for IT managers at the end of 2003 (Knorr 2003). It originally referred to a new software model (web services and outsourcing), and by extension to an economic model in which the software is no longer tested at considerable expense in closed user groups before being commercially released, but remains in a kind of permanent "beta status" and is constantly being improved by active users and on the basis of the feedback they provide. As this happens, it is quite possible for new versions of a software to appear on a daily basis (see for example O'Reilly 2005). These innovations and groupings of services have been hyped as a new phase of the Internet; the decimal term 2.0 is taken from software jargon, where it is used to refer to a new, significantly revised version. One of the most important technical characteristics of these innovations is that the web is now seen as a "platform" rather than just as a way of storing data on a large scale. From the point of view of the users, it is no longer just the content but in part the software itself that is no longer to be found on the local computer. This means that the goal of interactive access from any location is on the way to being attained. The new software architecture makes it possible, to an unprecedented degree, not only to combine content from different points in the network, but also software modules. They are fused and recombined to become what are known as "mash-ups", i.e. Internet pages where the different parts (graphics, text, the contents of databanks, software, interactive elements, etc.) come from different sources.

The most important characteristic of Web 2.0[1] in the present context relates to the "*architecture of participation*" (O'Reilly 2005). This means that contributions are made in a decentralized way, both by the programmers and by the users. In this context, Bruns (2008) speaks of "produsage", observing that today the traditional distinction between production, distribution and reception would no longer be adequate (in section 3.2 we will come back to this thesis in the light of our empirical findings of chapter 2).

1 This is not the place to present the ongoing conceptual debate around the term "Web 2.0": see e.g. Berners-Lee (2006) and his critique of the term referring to the original concept of Web 1.0, and e.g. Wu Song (2010) for a deeper theoretical and critical perspective on the concept. Despite its historical and theoretical weaknesses, we decided to use it for pragmatic reasons, simply because it is widely used.

The term "crowdsourcing" originally described outsourcing the development of software modules to programmers working online, without payment, in their spare time. It has become a popular term and principle which is now used in a number of different settings.[2] Today various kinds of content such as texts, videos and pictures are increasingly developed by the users themselves with the help of Web 2.0 technology. The term commonly applied in this context is "user-generated content". Instead of aiming at a mere passive consumption of content, Web 2.0 developers try to take advantage of the interactive functions of their tools, also for shaping the technology itself. It is very difficult to use the conventional language of copyright to capture the result of this process. Consequently, this development is associated with the "open content" movement, which supports the reuse of software in different settings without restrictions. Scientists, too, now speak of "science commons" as part of the "creative commons" (Wilbanks 2005).

Here are some examples of typical Web 2.0 applications. Recently especially social network sites such as Facebook gained a lot of attention. They are mainly used for identity management, self-marketing and networking, i.e. getting in touch with others with shared interests (see 2.1). There are also Web 2.0 applications which make it possible for users to become authors themselves in an uncomplicated way, in particular web diaries or "weblogs" ("blogs" for short). Microblogging services enable users to send short messages that resemble diary entries (see 2.2.), and there are various kinds of wikis, which are collaborative and, unlike earlier groupware applications, public forums where written contributions can be posted. The best-known example is Wikipedia, a global, free encyclopedia compiled, potentially, by all its users (see 2.3). Another group of typical Web 2.0 applications which also serves as a way of sharing knowledge without creating primary content is "social bookmarking", which is the collection of links to websites and online publications on related themes. This results in so-called "folksonomies", which in the new web are replacing and complementing the traditional taxonomies centrally controlled and updated by specialists: By means of "collaborative tagging" or "social tagging", users allocate web content descriptors without reference to any rules and so make it accessible to others; this means that the tagged elements (e.g. web-

2 For example, Bry and Herwig (2009, 31) also use "crowdsourcing" with regard to the concept of "open innovation" to refer to the outsourcing of "research work to a large, barely defined crowd of people".

sites or publications) are collated in a comprehensive, albeit "unprofessional" way via the volume and weighting generated by the frequency with which the tags are allocated (see Bruns 2008). Podcasts, series of audio or video data made available online, are also counted as part of Web 2.0 to the extent that they are often not produced by professional mass media (however such professional radio content is also increasingly becoming available as "podcasts"). Virtual worlds are another area of Web 2.0, and are also shaped and characterized by their users and their behavior (see 2.4).

We can sum up by saying that what has become known as Web 2.0 largely builds on the elements that were part of the early Internet phase and which foster interactivity and the joint production of content. The early Internet was to a great extent a top-down medium—with some exceptions such as chatting services or discussion lists—in which established providers or those in the course of establishing themselves, but at any rate relatively few providers, made content available (classic "one-to-many" communication). The main focus of what is now emerging is that in addition to the traditional forms of communication, which continue to exist, practically every user can become a provider ("many-to-many" communication). Although this was already possible in the early time of the web, the new applications make this process much easier. Moreover, the much greater bandwidth of most Internet connections has now made many of the new services widely usable for the first time and so made them relevant to society as a whole (at least in developed countries). Together with the emergence of new social networks and online communities, this phenomenon is evidence of the Internet's development towards a social space. However, it remains to be seen if the expectations caused by this development are fulfilled.

1.2.2 Social media, digital social networks and digital social culture

Many connect this development with terms such as *social media* (Kaplan and Haenlein 2010), *digitally enabled social networks* or *digital social networks* (DSN) (e.g. Grange and Benbasat 2009; Nordan et al. 2009; Bampo et al. 2008). According to Kaplan and Haenlein (2010) the concept of social media refers to "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user-generated content". This also supports novel forms

of social interaction. Social interactions are the building blocks of social networks, which are more or less stable social structures made up of network entities or nodes (individuals and/or organizations). These nodes are connected by one or more specific types of interdependency, such as friendship, kinship, common interest, financial exchange, dislike, sexual relationships, or relationships of beliefs, knowledge or prestige. Expanding to the digital world, we understand by DSN with Grange and Benbasat (2009) "web applications that enable people to create social networks, i.e., when users—or their representation in virtual environments—are network entities connected to each other by links of various nature, such as awareness, friendship, proximity, mutual interest, etc.". These networks may either relate to existing non-digital or offline networks, or expand on them, or be fully independent from any pre-existing network outside the digital space. The term DSN contains three important elements: *digital* describes the specific technical shape which determines the communicative possibilities; *social* refers to the interactive practices between the users; and *networks* points to the significance of interlinked web-like structures. On the one hand, these can be the outcome of such practices; on the other hand, existing offline networks pre-structure these digitally-mediated networks.

DSN are on the rise and have become important factors in many fields of modern societies, from journalism to business—not least in academia—challenging established structures. Due to their digital nature, ICT play a significant role in intermediating between the involved actors. While DSN could already be established with tools available in the early Internet, in particular by means of e-mail listserv or web-based forums, the interactive and participatory nature of Web 2.0 technologies is particularly suited to support building them. Note, however, that further technologies also profoundly shape these networks, e.g. search engines like Google—that is why we included them in our case studies alongside typical Web 2.0 platforms.

DSN contribute to an emerging *digital social culture*. By this we mean the specific networking and communicative activity and behavior of humans online and intertwined with the offline world. We observe new patterns of written communication in a blended synchronous-asynchronous mode, with even new terminologies, new social norms with regard to responsiveness and timeliness, novel kinds of assessing the usefulness and quality of resources, ad-hoc forms of collaboration with a high degree of work-sharing, etc. All this contributes to the slow evolution of a new kind of culture in the sense of customs, "how-tos", and standard practices.

1.2.3 On the path to cyberscience 2.0?

When we first studied the phenomenon of cyberscience in 2003, Web 2.0 was still in its infancy. Today, it is everywhere: millions of people all over the world, including many scientists, have become part of the rapidly growing digital social networks that are fostering the development of the new services. Elements of some of the phenomena, that we would today subsume under the blanket term Web 2.0, were already visible in 2003: some academic journals were experimenting with open review procedures, known as "open peer commentary" or "open peer review" (Pöschl 2004, 2007; Nentwich 2003, 371ff.; 2005b). There was also discussion of the possibility that the knowledge accumulated by the sciences could be stored in new kinds of hyper-databanks which would be collectively maintained and updated (Nentwich 2003, 270ff.). Even at that time, there was extensive discussion of the way in which readers could also become, to a certain extent, authors, or "wreaders", which meant that there would be an increase in multiple authorship and, thus, a situation in which texts could no longer be attributed to particular authors. By then it was possible to discern that the new media had the potential to, as it were, open new windows in the ivory tower of science and to contribute to the removal of the traditional, strict distinction between communication within science and communication between science and the outside world.

In 2003, these considerations were still largely speculative. Now that Web 2.0 services have arrived, they have become of much more immediate concern. If one looks at the new phenomena, described briefly above, it rapidly becomes clear that the changes set in motion by e-mail, e-mail discussion lists, video conferences, groupware etc., which led us to speak of cyberscience—the digital communicative space of researchers—are now being strengthened or are providing, for the first time, the means by which this new form of science can establish itself.

It is quite clear that the setting up of collaborative knowledge resources (or net-based collaborative writing) is a development with great potential for use in science, and this is emphasized by the fact that scientists are already showing great interest in it. Virtual worlds could enrich distance communication in science, which has up until now largely been based on written texts, and it could even be the breakthrough that will make it possible to organize electronic conferences. Simultaneously, completely new forms of micro-publication are coming into existence, and so far there has been very little investigation of the effects these might have on formal and

informal communication between scientists. Finally, the tools that make it easier to share information are also of interest for the scientific enterprise, which relies on cooperation and the availability of information and the building blocks of knowledge, both in its overall constitution and within smaller working groups.

These observations—shared by a few other scholars (e.g. Hey and Trefethen 2008, 28; Bry and Herwig 2009; Waldrop 2008)—present us with a good opportunity to ask what new potential and what specific influence the new Web 2.0 services will have on science. We propose to use "*cyberscience 2.0*" to refer to forms of science influenced by Web 2.0 and to employ "Peer Review 2.0" in an analogous way in relation to potential changes in the academic quality control system (Nentwich and König 2010). Similarly, the term "Scholarship 2.0" has been coined to refer to new forms of academic publication,[3] and so has "Science 2.0"—this latter concept, however, is in our view sometimes used merely to provide a contrast with "Science 1.0", i.e. traditional science before the advent of the Internet, and so corresponds more closely to cyberscience (1.0). It is true, though, that the expression "Science 2.0" also appears in connection with Web 2.0 sites such as ResearchGate, which explicitly applies the model of the new Web 2.0 social networks to the setting up of a scientific community (see below 2.5). Waldrop (2008), on the other hand, speaks of Science 2.0 explicitly in the context of Web 2.0, and defines it as follows: "Science 2.0 generally refers to new practices of scientists who post raw experimental results, nascent theories, claims of discovery and draft papers on the web for others to see and comment on." The parallel German concept "Wissenschaft 2.0" is used in a similar way (e.g. by Bry and Herwig 2009). The future of libraries is discussed by using the terms "Bibliothek 2.0" (see Danowski and Heller 2006) or "Library 2.0" (Casey and Savastinuk 2006) in relation to Web 2.0 applications. Finally, one also sometimes comes across the term Publication 2.0 (for example, in one of the ResearchGate groups), which is used to mean academic publication using either open peer review or open access.

In view of the considerations summarized above, which had already been put forward before the appearance of what is now known as Web 2.0, there is no particular reason to adhere to the concepts as these authors use them. Similarly, Tim Berners-Lee has criticized the concept of Web 2.0 on

3 scholarship20.blogspot.com. Note: All URLs given in footnotes have been retrieved on 30 November 2011, if not stated otherwise.

the grounds that the same conception of a network was the basis of the original web, that is "1.0" (Berners-Lee 2006). The question of whether or not the label cyberscience 2.0 is indeed appropriate, on the grounds that qualitatively new aspects have been added, and whether for this reason the conceptual demarcation (and fashionable creation of concepts derived from software development) is justified, will be examined in the course of this book (see in particular our conclusions in chapter 4).

1.3 Conceptual Framework and Methods

With a view to answering our main research questions—What role does the digital social culture, triggered by Web 2.0, play in the academic world at present and what are the potentials of platforms such as Twitter, Facebook, and Wikipedia? What impact will the emerging socio-technical practices have?—we apply and only marginally adapt the same exploratory approaches and the same conceptual framework that have been developed for and applied by the previous cyberscience study (Nentwich 2003, 1ff. and 21ff.; 2005a). In this section we briefly summarize this framework and our empirical instruments.

1.3.1 Modeling scholarly activities and ICT impact on academia

As in the previous study our main object of research, our dependent variable in a broad sense, is the scholarly communication system (1); the "independent", though dynamically changing, variable are the information and communication technologies, which are in this study mainly the emerging Web 2.0 platforms (2); furthermore, we will have to cope with a series of intervening variables that influences the changes under way (3).

(1) The scholarly communication system consists of a series of actors (all researchers worldwide) and their institutional, research and communication infrastructure. Our main focus is on the typical scholarly activities performed within this system. All of these activities are of a communicative nature and we may distinguish (with Gibbons et al. 1994, 36ff.) three layers of communication: with the object of research, with other researchers (and research-related) staff, and with the external world. From a proce-

dural point of view, we distinguish the following types of scholarly activities:

- *Knowledge production:* At the heart of all research activity lies the systematic and creative processes of producing new knowledge. These include information gathering, data production and processing, analysis, and data management.
- *Communication (knowledge processing):* The knowledge produced in the laboratories, in the field, and on the desks is constantly processed among the researchers: they exchange it and collaborate around it, they discuss and evaluate it in seminars, at conferences and in the framework of formal quality control procedures.
- *Distribution of knowledge:* Once produced and evaluated, the knowledge is published and informs further researchers, is used in teaching, and possibly implemented, for instance in a product or as policy advice.

To these scholarly activities, directly related to the research processes, we may add the *institutional settings* in which these activities take place. These relate to the organizational setup, such as the types of research institutions, the technical equipment, recruitment procedures, fund raising and project acquisition, etc.

In this model of scholarly activity the elements partly overlap. For instance, knowledge representation, i.e. the way research results are presented in written or other forms, is part both of producing and of processing knowledge; likewise publishing research results belongs both to knowledge processing and distribution. These activities are not linear "steps" to be performed in succession (production—communication—distribution), but are part of an iterative process. For instance, a preliminary result of the production phase is being discussed among colleagues; the discussion challenges the result and leads to further research. This is especially the case in the context of Web 2.0 as pointed out e.g. in the concept of "produsage" (Bruns 2008). We are not denying these instances of blurring, but we believe that a general separation of these typical activities is still appropriate for analytical purposes (we will come back to this issue in section 3.2). In Figure 1 the overall picture of scholarly activities and their framework conditions is visualized.

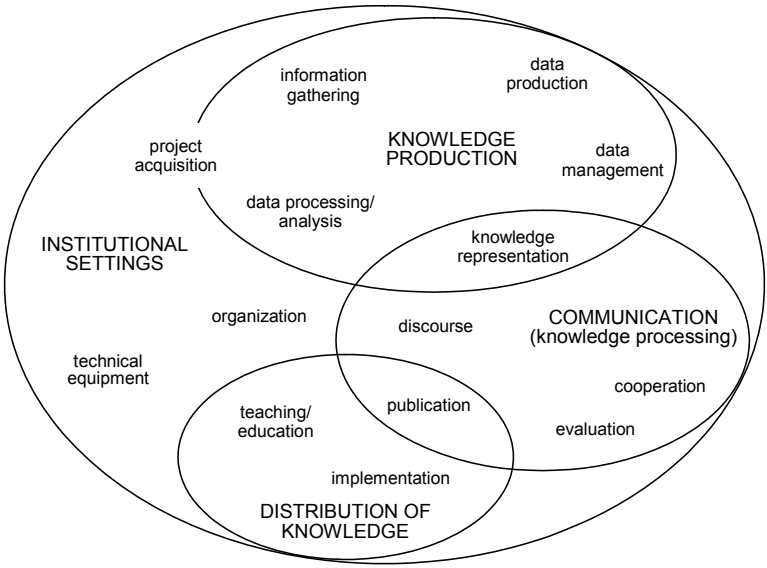

Figure 1: Types of scholarly activities and framework conditions

Source: Nentwich 2003, 24

As previously noted, one of the main results of the earlier cyberscience study (Nentwich 2003) is that, in principle, all of these types of scholarly activities and framework conditions are somehow affected by the widespread diffusion of ICT, in particular the Internet, in science and research. In this book, we assess whether this also holds true for the new Web 2.0 platforms and other maturing Internet services. Therefore, when we present our case studies in chapter 2, we will use the above model (and figure) in order to find out in which field of scholarly activity the respective platform or service may potentially influence the overall picture.

(2) The case studies will be devoted to describing and analyzing the development of the independent variables in this study, i.e. the various ICT applications, such as microblogging platforms or social network sites. Along the diffusion path, the technological tools become gradually adapted to the needs of academia. For instance, users' feedback will be acknowledged by the developers, which is particularly likely in a Web 2.0 environment (see above 1.2); or scholars and scientists "appropriate" the tools in a way not expected by the designers (we will present such examples in chapter 2). In other words, although set as the main independent variable in our