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The Digital Researcher: Exploring the Use of Social Software in the Research Process

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Abstract
Web 2.0 and social software have long since reached research. Existing examples and even studies show, that researchers use social software during the research process. However, the ways social software can be used to support research work are still not sufficiently explored. In this paper, we suggest that this question can be addresses systematically by means of a simple exploration framework. We base the framework on the research process and the activities connected to it. We use the framework for exemplary consideration of selected social software.

Keywords: Collaboration, Web 2.0, Social Software, Research Communication, Research Process

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1 Introduction

Defining scientific research is a complex task. A simple way of describing scientific research would be to depict it as a process. The research process uses existing knowledge and experience of the scientific community to create new scientific knowledge. Due to this 'reuse', the communication of scientific results plays a crucial role in science. The development of technology has as of today led to significant increase in the speed of the dissemination of scientific findings. Traditionally, since the development of the letterpress, primarily printed media have been use for scientific publication. Later, the Internet has provided a platform for scientific communication and collaboration. The development of Web 2.0 and Social Software have simplified the communication and collaboration on the Internet so far, as to allow it to change from a primarily data network to a network with social structures.

The term Social Network has been coined by Clay Shirky [24] [25]. There are different, sometimes competing definitions of the term. In this paper, we define Social Software as applications based on the new development in Internet technology, which allow (directly or indirectly) human interaction (coexistence, communication, coordination, cooperation) and which map and support the relationships among the users of the World Wide Web [22]. The use of Social Software for the communication among scientists has not yet been fully explored. In the practice, the use of Social Software in research often resembles 'trial and error', rather than a strategic and purposeful implementation. Among the newest examples of this practice is the (apparent) influence of the use of microblogs by scientists on their scientific blogs [23]. It is therefore necessary to systematize the use of social software in research and science. To attend to this demand, we have created a framework for the structured exploration of the use of Social Software in scientific communication. The aim of this paper is to present this framework and explain its implementation for different Social Software Services.

2 Research Process

Research, as a systematic enquiry leading to the construction of new knowledge [8], does not take place solely in science. It is also carried out daily by each individual. However, scientific research (also scholarly research or academic research) follows particular guidelines and procedures to ensure the quality of research results. Scientific research intents to create scientific knowledge in particular field through the process of systematic scientific enquiry, the research process [4]. The research process as well as the research results have to fulfil certain standards [10] [26]. Among others, scientific research must be public, replicable, unprejudiced and independent and it must advance the state of the art [10] [26]. Due to this crucial role of the research process in science, the understanding as well as the theoretical analysis of the research process are relevant for any research directed towards improving and supporting science [27].

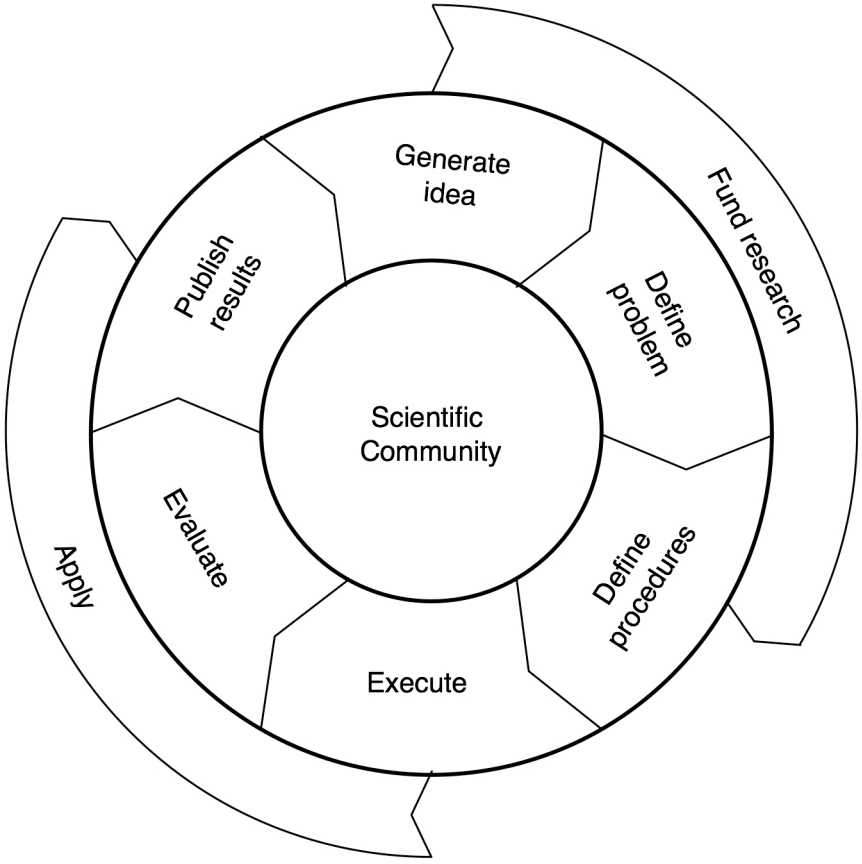

Figure 1: General research process

Figure 1 presents a model of a cyclic research process (for detailed discussion and literature review see [4]). The whole research process is centred around the **scientific community**. The scientific community is the knowledge base containing the existing scientific knowledge. The researchers can benefit from this resource and contribute to it by communicating (formally or informally) with other scientists. The activity in a research process always begins with an **idea**. The source of the idea can differ. Applied research often generates its ideas based on practical problems. The discourse with colleagues, the study of scientific literature or just the researchers 'hunch' can also lead to a new idea. The idea-generating phase is highly creative and ill-structured. The research idea is not yet suitable to for scientific research and has to be further refined. For this, the author has to reflect upon the idea and consult existing research as well as other relevant literature. The idea is then developed into a precise **research problem**. The precision of the problem description can differ. Depending on the problem, but also the discipline and even the researchers' preferences, the definition of the research problem can have different levels of precision [8]. The **procedures and the methods** of the research have to be defined beforehand. This ensures the quality of the outputs from the execution phase. A written proposal that serves the presentation of the research project as well as a plan for the researchers executing the research may also be necessary. Every research project requires **resources** in form of time of the participating researchers and assistants, equipment, services etc.. Sometimes, the resources are provided by the researchers in charge or their institutions. Other research projects need to apply for external funding. In any case, the use of the

resources will have to be argued and justified. The instance providing the funding will only fund such research as is consistent with its aims. The search for funding will therefore influence the research project. The definition of the research procedures may be restricted (e.g. by given time span, maximum funding, or available funding type). Similarly, the focus of the problem definition may be directed by the aims of the funding institution (e.g. focus on a specific population). Even the idea generation can be influenced by available funding (e.g. the idea may arise after reading a call for research proposals). The activities in the **execution** phase are governed by the previous selection of procedures and methods. The **evaluation** phase is closely connected to the execution phase. This phase is common to the different research approaches, although its exact content may vary. Its aim is to analyse and evaluate the results from the execution phase. The scientific research process thus demands a critical analysis of the 'raw' findings. This serves to ensure the quality of the research results. The **application** of results in the practice is not a necessary part of every research process. Some disciplines do not consider the application of research results the researchers' responsibility. Other, applied disciplines see it as a necessary part of research. Connected to the application of research findings is the **publication** of research results. Researchers can assist the application by publishing the research results in media addressing relevant practitioners. In this phase, the results of the research are summed up and published in suitable media. Scientific research would typically be published in scientific journals, books or presented on conferences. However, publication in media addressing practitioners could also be relevant. We have deliberately called this phase 'publish result' and not 'communicate results'. Scientific publishing is a formal, well-structured process with long tradition. Typically, only research results are a subject to scientific publication. Whereas communication can be also an informal, unstructured exchange among the researchers performing the research and the scientific community or other individuals. Communication can take place throughout the whole research process.

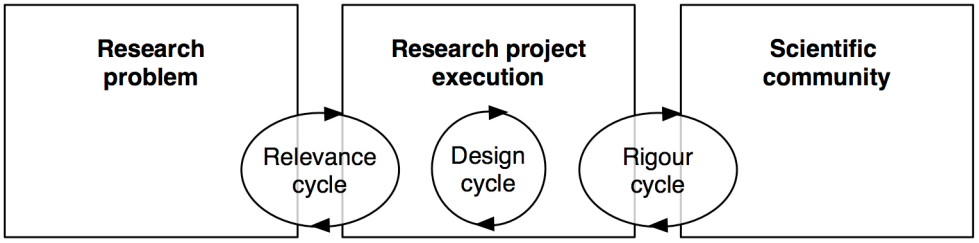

Figure 2: Research cycles (compare [12])

A research process does not always have to strictly follow this cycle. Smaller iterations also often take place within the main cycle (Figure 2). A scientific research projects contains three cycles, which are iterated according to the researchers' needs. The **relevance cycle** ensures that the research activities are connected to the original research problem. The relevance cycle can lead to the iteration between the phases describing the problem and defining the design as well as the phases concerned with the execution and the evaluation. For research processes concerned with a practical problem, the relevance cycle would also guide the connection to the environment of focus. The **execution cycle** iterates between the execution and evaluation phase, leading to satisfactory results. Finally, the **rigour cycle** provides a connection to the scientific community. The rigour cycle can use iterations concerning nearly all phases of the process. Through the rigour cycle, the researchers can constantly check their activities and findings against the knowledge existing in the community, its methods but also values and practices.

3 Activities and Research Framework

There are eight individual activities in a research process that require IT-support. Beside the individual activities there are also team activities, aiming to support the collaborative research [27]. Individual activities are directly related to the research aim itself. They have to be carried out independent of whether the research is done by one individual or by a team, in closed or open science way. Nevertheless, through a transparent presentation of activity results, the individual researcher could generate effects for a team (e.g. in a shared literature database) or for the crowd (e.g. Social Tagging). In this paper we focus on the five individual activities: exploration, retrieval, reading, writing and dissemination [27] [32]. Besides the mentioned functions there are further activities in the research process like analyzing, data collection and interpretation as individual functions or goal alignment or coordination as functions for project teams [27]. For these activities an ICT support with web 2.0 tools is also possible and available but not in the focus of this paper.

Exploration is a search for information with only a diffuse knowledge about the needed information or about the way to get them. It can be appear in different forms e.g. as browsing the web, databases or libraries. By contrast, for **retrieval** the knowledge about the needed information (e.g. a concrete article) or the approach to get the information in one context (e.g. boolean retrieval in a literature database) is more concrete. **Reading** in the meaning of knowledge work is not only seeing. It is working with literature and can range from little post-its or highlights to comparative article summaries. The **writing** process can be understood as a 'dialogue with the (electronic) paper'. Scientific writing makes high demands on the use of language (e.g. terminology), the structure of the text and the formal criterions for citations. Depending on target group, different ways can be chosen to disseminate research results (or partial results). The common essence of dissemination activities is to publish own content to a broad public.

Because of there general nature, these five activities are observable in every research phase. To examine the opportunities for ICT-support for researchers and other knowledge workers we build a matrix with the process phases on the one hand and the functions on the other. Thus the complexity should be reduced and it is possible to analyze the contribution of a special social software application in the research process.

4 Using the Framework

Following we describe a list of cases where social software services support an area in our matrix. Therefore you can differentiate between social software services which intentionally support scientific work and which don't have this specific field of application.

Social bookmarking has the aim "to store, organize, search, and manage bookmarks" [31]. It's a form of public link management with a social networking flavour or an open and unstructured approach to tagging of resource links (compare [9] [14]). Through collective or collaborative tagging users create a folksonomy. One popular social bookmarking service is delicious. The purpose of delicious[1] is to save, manage and share links to any form of web pages. Beside these services for general use, there also services with a scholarly focus. CiteULike[2] and Connotea[3] are

[1] http://delicious.com/

[2] http://www.citeulike.org/

social bookmarking services to store, organize, share and discover references of scholarly publications. Both provide functions to import references including all bibliographic details from a web page (e.g. amazon) via browser button in a personal online library. The library can then be exported in a standardized format (e.g. BibTex). Like general social bookmarking tools you can organize your references by tags and see which references other persons have tagged. Additionally you can find out, who else also has a specific reference in the library, build groups with other people and share references and papers.

There is a broad area of application for social bookmarking in the research process. The general services like delicious can be used for exploration in three ways: (1) In an exploration process via browsing or searching using a search engine (e.g. google) you can save and organize the found resources in a very flexible way. (2) You can explore the folksonomy topic-oriented. (3) Provided that you could identify interesting people in your area of interest, you can explore their tagged resources. Given that general social bookmarking has not a scholarly focus, there is no apparent limitation to a special research phase, but the major benefit is in exploration. In comparison, services for academic papers like CiteULike further have the ability to support retrieval, reading and writing. For retrieval there are the same (or at least similar) functionalities like in literature databases (e.g. boolean operators and field search). When reading an article you can store your notes and ratings direct to the reference and share it with other. The writing support could be divived intp (1) the automated capturing of bibliographic data and providing a standardized format and (2) the use of a shared data basis (collected in a group) by writing a common publication with others.

Weblogs or blogs are web pages with a list of dated entries that are typical displayed in a reverse-chronological order. The target groups of weblogs can differ and so the entries vary from short opinions or references to large reports with citations. Most weblogs allow the readers to comment entries and to arrange the entries by categories or tags. In the scientific world, blogs are well established for a fast dissemination of information. Portals like ScienceBlogs[4] or scientificblogging[5] have evolved, which aggregate and organize scientific blogs to different subjects [28]. The use of such scientific portals or search engines for blogs (e.g. Technorati[6]) is an appropriate way for exploration in the phases of idea generation and problem definition. Besides this primary benefits there are also indications that the use of blogs could support the writing process (especially for untrained writer), because of the possibility for fast reflections and feedbacks [6].

Microblogging "is a form of multimedia blogging that allows users to send brief text updates or media such as photos or audio clips and publish them, either to be viewed by anyone or by a restricted group which can be chosen by the user" [30]. The first and most popular microblogging service is Twitter[7]. The primary idea behind Twitter was that people could tell their friends what they are doing. Therefore you have the possibility to connect with other people and to post your status. The service is so flexible that the users do not have to be people and the content does not have to be to be only status information. Institutions (e.g. radio stations and newspapers) use the platform to disseminate information [15] and people have conversations via Twitter [13]. So it is

[3] http://www.connotea.org/
[4] http://www.scienceblog.com
[5] http://www.scientificblogging.com/
[6] http://technorati.com/
[7] http://twitter.com/

not surprising that also many researchers use the platform to disseminate ideas, hints, meanings and references [3]. Thus Microblogging and especially Twitter seems to be a good opportunity to disseminate short information or updates in all research phases and to explore new ideas or meanings, links to resources, events and facts by observing the twitter stream of scientists and other interesting persons.

By now wikis are so popular that a definition can hardly describe what a wiki is and what could it be used for. The probably best-known wiki is the free online encyclopedia Wikipedia. The developer of the first wiki, Ward Cunningham, originally described it as "the simplest online database that could possibly work" [5]. The most wikis serve the purpose of collaborative hypertext creation with a simplified markup language. In the scientific field, wikis are successful used as a simple way for documentation and sharing of knowledge in a specific subject e.g. in chemistry [28] and biology [21]. Given that on the one hand the peer review is not so highly controlled as in a high-ranked journal and on the other hand most researchers need publications in journals or books for several purposes (not least the reputation) at present the major field of application is in the phases of idea generation, problem definition, procedure design and procedure execution.

The self-description of the service WikiCfP[8] labeled it as a wiki [29]. But with the given definition that a wiki is hypertext, the WikiCfP service could hardly be described as a wiki because of the absence of links between the pages. The service provides functions to store calls for papers in a structured way and to organize them with tags and categories. All stored calls and tags are public and could be searched by other users. In the phase “publish results” the WikiCfP service supports the exploration of potentially publishing platforms in two ways. On the one hand, found calls for papers could be stored in a structured form and collected in a list. On the other hand the calls in the WikiCfP could be explored on the basis of categories and tags. The retrieval of potential publishing platforms is supported by a search function for title, place and category. Generation of a timeline with deadlines and the export of a calendar file support the dissemination itself.

[8] http://www.wikicfp.com/

Research process \ Activities	Exploration	Retrieval	Reading	Writing	Dissemination
Generate idea	1,2,3, 4,5	2	2	2,3,5	3,4,5
Define problem	1,2,3, 4,5	2	2	2,3,5	3,4,5
Define procedures	1,2,3, 4,5	2	2	2,3,5	3,4,5
Fund research	1				3,4
Execute & Evaluate	1,5			3,5	3,4,5
Publish results	1,6	6		3	3,4,6
Apply	1				3,4

Legend:
1 – General Social Bookmarking
2 – Scientific Social Bookmarking
3 – Scientific Blogs
4 – Microblogging
5 – Scientific Wikis
6 – WikiCfP

Figure 3: Exploration framework

The results of our analysis of social software services are summarized in Figure 3. It shows that the main part of activities in the research process is supported. Especially the early phases of the research process and the activity of exploration could be emphasized.

5 Conclusion

The framework with activities and research phases appears adequate for a structured exploration of the use of social software in scientific communication. It is however necessary to enhance the framework with further activities (e.g. analysis, data collection and interpretation) as well as with activities related to team collaboration [27]. This would allow the study of more types of Social Software Services, e.g. the social data analysis tools [1] Swivel[9] and ManyEyes[10]. We also have to analyze, if and why scientific social networking services (e.g. Academia.edu[11]) have no apparent influence on the research process. Building on the structured exploration with our framework, we want to study, which services are complementary and which are competitors. In the former case, a technical integration of complementary tools would be of advantage. In the latter case, we wish to support scientists in the choice of their tools.

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