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Speeding Up the Spiral: Analysis of the Effects of Open Access on Scientific Knowledge Creation

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Speeding Up the Spiral – Analysis of the Effects of Open Access on Scientific Knowledge Creation

Journal:	*18th European Conference on Information Systems*
Manuscript ID:	ECIS2010-0313
Submission Type:	Research Paper
Keyword:	Conceptual modeling, Public sector, Knowledge management, OSS/FLOSS

SPEEDING UP THE SPIRAL – ANALYSIS OF THE EFFECTS OF OPEN ACCESS ON SCIENTIFIC KNOWLEDGE CREATION

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Abstract

This paper analyzes the effects of open access (OA) on the creation of scientific knowledge. In a first step, drawing on the theory of Nonaka and colleagues, their SECI model is applied to the processes of knowledge creation in science. Typical activities of the research process are assigned to the four knowledge conversion modes socialization, externalization, combination, and internalization. Subsequently, on the basis of the resulting framework it is shown how OA affects scientific knowledge creation. We conclude that (1) with regard to the epistemological dimension of knowledge, OA decreases the time of running through the SECI cycle, and (2) concerning the ontological dimension, OA enlarges the number of possible receivers of newly created knowledge. Those propositions provide a basis for further empirical studies within the introduced framework.

Keywords: Scientific knowledge, Open Access, SECI model, Knowledge Creation

1 INTRODUCTION

In recent years the Open Access (OA) movement has attracted a great deal of public's attention. The number of scientific articles that are deposited either in institutional or subject-based repositories or published in OA journals has increased rapidly. But, compared to the majority of toll access papers in traditional journals, this development yet is a drop in the ocean. On the one hand, though the vast majority of researchers support the OA paradigm, many of them are reluctant to actually "do" OA by themselves (Mann et al. 2009). On the other hand, the traditional system of journal subscriptions is sustained by libraries and unchangingly funded by the public (Bernius et al. 2009).

OA advocacy usually bases on two main arguments: first, OA increases the research impact of an individual author (Eysenbach 2006, Craig et al. 2007, Bernius & Hanauske 2009), and second, OA decreases the costs of the scientific publishing system in general (Houghton et al. 2009). These arguments concerning the benefits of OA are normally supported by empirical quantitative data – in most cases a deeper theoretical grounding of the possible advantage of OA over the traditional publishing system is not provided. Hence, in opposition to many "pro-OA papers" this study draws on a well-established theory when assessing the potential of OA to positively influence the most essential target of science: the creation and communication of new knowledge.

We attempt to answer the research question "*How does OA contribute to scientific knowledge creation?*" by applying the theory of organizational knowledge creation by Nonaka and colleagues (1994, 1995, 1998) to the processes of knowledge creation in science. In a first step, a conceptual framework is presented that assigns typical activities of the research process to the four knowledge conversion modes (socialization, externalization, combination, and internalization) postulated in Nonaka's SECI model (Nonaka & Takeuchi 1995). In a second step, on the basis of the resulting framework different effects of OA on scientific knowledge creation are explicated. The research method used in this study can be classified as analytical conceptual research (Wacker 1998, p. 373). The resulting propositions should serve as starting points for further theoretical and empirical research in the field of OA.

The paper is structured as follows: in the next section we give an overview of different approaches to realize OA. Section 3 focuses elaborately on Nonaka's knowledge creation theory. Besides describing the important elements of the SECI model, the chapter discusses criticism of the theory and motivates the decision to draw on the SECI model. In section 4 a framework is presented, which shows how the SECI model can be transferred to research in general. Section 5 addresses the contributions of OA to scientific knowledge creation. The paper ends with a conclusion and suggestions for further research.

2 OPEN ACCESS MODELS

Figure 1 shows different popular ways to OA. On the one hand, there are models which completely meet the requirements stated by OA advocates. We refer to these variants as "true" OA. On the other hand, there are many models – mostly initiated by publishers or libraries – which only lead to weak forms of OA, not totally fulfilling the purpose intended in the OA declarations. We subsume these variants under the term "hybrid models" (Bernius et al. 2009).

Nearly all scientific journals that are electronically available provide Partial OA to their content, so that access to some parts of the journal (e. g., the table of contents, abstracts, or the editorial) is free. This also includes the practice of some journals to make pre-prints of articles that will be published in the forthcoming issue freely available for a short time. Delayed OA, however, means that a publisher allows access to journal articles after a certain time period (embargo), after which the exclusive rights of the article fall back to the author. Typically, this embargo period lasts 6, 12 or 24 months. Publishers who grant the right of Optional OA leave the decision to the author as to whether an article

can be openly accessed or not. Through payment of a fee, the author can assure the free accessibility of her work. Springer, for example, utilizes this model within the so-called "Springer Open Choice" program. A problem concerning this model results of high publication fees (in the case of Springer US$ 3000 per article), which may have a dissuasive influence on authors concerning the actual use of this model. Beside these possibilities of making scientific papers subsequently available, Retrospective OA includes access to retro-digitalized material such as older journal volumes. These hybrid models correspond only conditionally with free access to scientific work as claimed by the OA advocates. There are, in fact, two other ways of achieving "true Open Access": OA journals ("Golden Road") and self-archiving by the authors ("Green Road") (Guedon 2004).

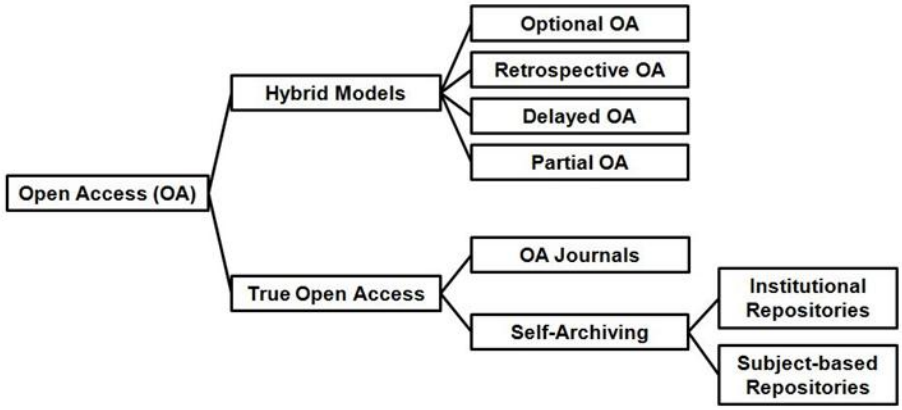

Figure 1. Different approaches to realize Open Access (Bernius et al. 2009)

OA journals differ from traditional scientific journals in a way that they make their content freely available via the internet, so that those who are interested can download and read the papers. This publication model is consistent with a fundamental change of publishers' business models. When subscription to a journal with OA articles becomes obsolete, the receipts can no longer be generated by libraries or private end users (e. g., individuals or industrial groups). Therefore OA publishers resort consequently to producer-side financing by the authors or their institutions. They have to pay a publication fee – some journals also charge submission fees – if their article is accepted for publication. In this connection, an important difference between the traditional publication model where the revenues of a publisher increase with the number of subscriptions, and the OA journals model becomes obvious: The income of OA journals is fixed, if publishers rely only on publication fees and keep the number of articles constant (an increase of the papers published is not without problems because of article processing costs, print costs, and peer review capacity).

For many OA advocates *self-archiving* of scientific work by the authors has become the most desirable model (Swan 2007). Authors can choose between institutional or subject-based repositories to deposit their work. An *Institutional Repository* (IR) aims at bundling the research output of an institution (e.g., a university or a research center) and makes it available to the public. In the majority of cases these document servers are run by the libraries belonging to the institution. With regard to this form of self-archiving, the lack of willingness on behalf of scientists to upload their work on these servers still is a major problem: articles are deposited mainly by librarians or administrative staff (Xia & Sun 2007). The situation is different when looking at *subject-based repositories*, which bundle research output of specific scientific disciplines. The prime example of an adoption of a subject-based repository is the pre-print server arXiv (http://arxiv.org/), which is used by physicists and mathematicians. Researchers in these communities self-archive pre-prints of their articles on arXiv and often additionally submit the papers to regular, peer-reviewed journals. The publishers in these disciplines thus renounce the claim that only unpublished work will be accepted. Such pre-print repositories are also imitated in other scientific disciplines. In economics, for example, RePEc

(Research Papers in Economics; http://repec.org/), the world's largest collection of online economics working papers, is a collaborative effort of hundreds of volunteers in 64 countries to enhance the dissemination of research in economics. Websites like EconPapers (http://econpapers.repec.org/) provide access to the RePEc database and offer tools to browse or search within more than 278.000 pre-print articles. The Social Science Research Network (http://www.ssrn.com/) with its eLibrary database is another example of a successful subject-based OA repository.

3 NONAKA'S THEORY OF KNOWLEDGE CREATION

3.1 Dimensions of Knowledge

In their model of knowledge creation in organizations Nonaka and Takeuchi (1995) distinguish between *tacit versus explicit knowledge* (epistemological dimension) on the one hand, and individual versus collective knowledge (ontological dimension) on the other hand. The distinction between tacit and explicit knowledge draws back on approaches by Gilbert Ryle (1949), who differentiates "knowing what" from "knowing how", and Michael Polanyi (1966), who introduced the idea of tacit knowledge in his book 'The Tacit Dimension'. The concept of Polanyi comprises the insight that 'all our thoughts encompass components which we register only indirectly, casually and beyond our actual cognition' and that 'we can know more than we can tell' (Polanyi 1966). Explicit knowledge is described as codifiable and convertible in formal, systematic language. Explicit knowledge is something that can be explained by individuals, and through codification it becomes readily accessible for others. Conversion processes from one form of knowledge into another play a key role in Nonaka's model – together with the ontological dimension: *individual versus collective knowledge*. The concept of individual/collective knowledge does comprise the concerns about the different levels of knowledge creating entities (Nonaka & Takeuchi 1995). According to Nonaka (1994), knowledge, at a basic level, is created by individuals. Every organization has to rely on individuals in order to create knowledge. The organization in which those persons operate, should target on supporting individuals in their knowledge creation and provide an enabling environment. Thus, knowledge can be held by individuals and then be disseminated among groups, organizations and inter-organizational.

3.2 The SECI model

The concept of knowledge conversion is the core idea in the theory of organizational knowledge creation of Nonaka and colleagues. In this context, the underlying and critical assumption is that 'knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge'. The authors identify four modes of knowledge conversion (SECI): **S**ocialization (conversion from tacit knowledge to tacit knowledge), **E**xternalization (tacit to explicit), **C**ombination (explicit to explicit), and **I**nternalization (explicit to tacit). This basic model is visualized in Figure 2.

Figure 2. The SECI matrix (Nonaka 1994).

Socialization is the process of sharing and creating tacit knowledge. Tacit knowledge is transferred from individual to individual without using readily accessible media. Language as a rather explicit medium can be involved but is not always necessary. The key to acquiring and sharing tacit knowledge is shared experience – otherwise individuals cannot "socialize" on a similar level and will lack mutual understanding. Nonaka and Takeuchi (1995) give various examples from the industrial world to explain socialization. The recurring concept is always the idea that socialization is carried out in rather informal meetings like "brainstorming". Such informal gatherings of different individuals (from maybe different backgrounds) are a forum for creative dialogue and effective in sharing tacit knowledge in order to create new perspectives and insights.

Externalization is a process where tacit knowledge (precisely: that part of tacit knowledge which can actually be articulated) is articulated into explicit concepts. In this conversion of knowledge, tacit knowledge becomes accessible in the shape of metaphors, analogies, concepts, hypotheses, models or written papers. Hence, externalization "involves techniques that help to express one's ideas or images as words, concepts, figurative language and visuals" (Nonaka & Konno 1998).

Combination is the knowledge conversion mode where different explicit contents are combined. This is conducted through different media such as documents, articles and formal meetings (e.g., face-to-face, telephone or computerized communication networks). Existing explicit knowledge is reconfigured or rearranged and leads to the creation of more complex sets of explicit knowledge. The combination phase encompasses three processes. It starts with capturing and collecting relevant explicit knowledge, and then disseminating it among the involved individuals or groups until – through editing or processing – the "old" explicit knowledge is converted into new and more usable forms (Nonaka & Takeuchi 1995, Nonaka & Konno 1998). Thus, combination is a process where different concepts and knowledge, even from different disciplines and sciences, are integrated into a knowledge system of any ontological dimension.

Internalization means embodying explicit knowledge into tacit knowledge. During this final conversion, knowledge is internalized into the tacit knowledge bases of individuals or groups. For example, the process of reading an article (explicit) while understanding its contents leads to internalization of the immanent ideas. Internalization can also be learning-by-doing, observation, training and exercises in an educational context.

3.3 The spiral view

Apparently, the SECI model is not a process that ends after one cycle. It is a continuous process and its distinct elements amplify each other. Nonaka suggests socialization as the starting point of knowledge creation. The outcome of the initial set of knowledge after undergoing externalization, combination and internalization is new knowledge which can trigger again the process of socialization – but on a higher level (regarding the ontological dimension and the complexity of knowledge). Hence, knowledge creation can be viewed as an upward moving spiral, which expands its circle of influence across boundaries like individuals, groups, departments, organizations or countries (see Figure 3). Furthermore, Nonaka et al. argue that knowledge conversion needs to be promoted by an appropriate organizational environment. They identify five enabling conditions: intention, autonomy, fluctuation and creative chaos, redundancy, and requisite variety. Those conditions build the environment, out of which the knowledge spiral emerges. However, these enabling conditions are not as universal as the SECI model itself and dependent to largely on context (Johnson 2002). Thus, their appearance and importance can transform and go beyond the original definition.

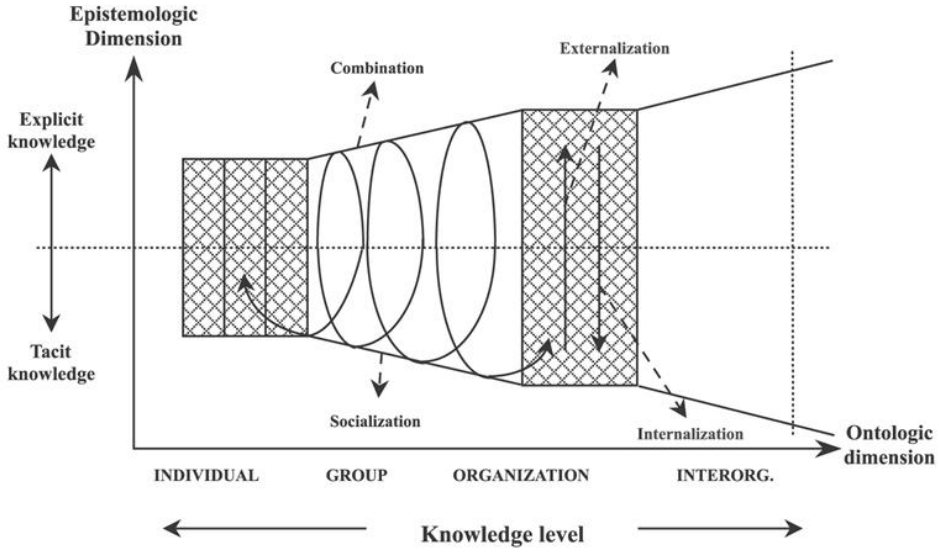

Figure 3. Spiral of organizational knowledge creation (Nonaka 1994).

3.4 Assessment and applications of Nonaka's theory

Despite (or because of) the popularity of Nonaka's theory of knowledge creation, the SECI model has also been criticized for different reasons. Hereby, the criticism is focused more on the philosophical grounding than on the applicability of the SECI model – mainly with the epistemological dimension of Nonaka's concept under attack. Some authors argue that, when defining tacit knowledge, Nonaka and Takeuchi are wrong when referring to Polanyi. According to Polanyi, tacit knowledge can never be codified and transferred into explicit knowledge – but this is a central point in Nonaka's model (for instance, Wilson (2002) argues that Nonaka and Takeuchi could have avoided such criticism, if they had replaced the term 'tacit' by 'implicit'). Nonaka's early attempts at rooting his theory in epistemology are indeed not completely convincing, but this does not mean that his theory in general has to be called into question. Many authors, including Nonaka and colleagues themselves (2006), have contributed to the tacit-explicit discourse and refined the definition of (tacit) knowledge. In this context, an important aspect is that tacit knowledge should be divided into different parts: tacit knowledge which is uncodifiable/unarticulable and therefore has to remain embodied in the individual versus tacit knowledge which can be made explicit (Howells 1996, Cowan & David & Foray 2000). The latter type is of interest when talking about knowledge creation in the sense of the SECI model.

Besides this criticism of the theoretical foundations of Nonaka's theory, alternative approaches to knowledge and knowledge management have also been formulated. An extension of Nonaka's model is provided by Salisbury (2008), who draws on the Collaborative Cognition Model and identifies four different types of knowledge: factual, conceptual, procedural, and metacognitive. Jashapara (2007) provides a realist theory in order to move beyond the relatively static discourse of tacit and explicit knowledge and acknowledges the key role of mind in forms of collective consciousness and organizational memory. Ray and Clegg (2007) suggest a radical constructivist approach as alternative to Nonaka and Takeuchi, and Tywoniak (2007) – building from evolutionary theories – refers to the dynamic nature of knowledge. He contrasts tacitness against personal embodied knowledge, socially embedded common knowledge and explicit knowledge. Theorizing the interrelation between these dimensions along the lines of the SECI model, Tywoniak sees the creation of knowledge as arising within this dynamic interaction – an approach that owes something to Blackler (1995) and other authors in the same line, who understand knowledge rather as "knowing-in-practice".

Compared to those alternatives, in practice Nonaka's SECI model seems to be by far the most applicable approach. It has been applied in various fields, including those of organization theory,

organization behavior, human resource management, innovation and technology management, public administration, and management information systems (see Nonaka & von Krogh & Voelpel 2006 and references therein). In their review article Alavi & Leidner (2001) drew heavily on Nonaka's ideas regarding knowledge conversion processes and develop them further in order to describe knowledge creation, storage/retrieval, transfer, and application as sets of which knowledge systems consist.

The SECI model in particular has been empirically tested with positive results in a variety of settings. For instance, Sabherwal & Fernandez (2003) conducted a survey at the John F. Kennedy Space Center with the aim to measure the influence of the four SECI modes on perceived knowledge management effectiveness. Among other things the results support the expected upward impact in perceived effectiveness of knowledge management from individual to organizational level. Schulze & Hoegl (2006) tested hypotheses related to the relationship between the four knowledge creation modes performed during new product development and new product success. Dyck et al. (2005) conducted a longitudinal case study in a manufacturer firm and provide an empirical examination of the basic elements of Nonaka's theory. Hence, an advantage not seen in most alternative models is the general applicability of the SECI model. This is also true for our case, as we will explain in the next chapter.

4 KNOWLEDGE CREATION IN SCIENCE

The idea of the conversion from unarticulated (but articulable) tacit knowledge into codified explicit knowledge that can be disseminated within the members of a community holds especially for the field of academic research, where sets of information have to be articulated in clear language including mathematical expressions, diagrams, models, etc. and – perhaps as the most fundamental point – citing the work (explicated knowledge) of other scientists. Day (2005) makes an interesting suggestion when saying that Polanyi's notion of "tacit knowledge" may be rephrased as "knowledge" and "explicit knowledge" as "information". For one scientist a paper written by another author represents a set of information until he/she reads it and internalizes the enclosed knowledge. This perception comes close to the idea Nonaka and colleagues have about tacit and explicit knowledge. Since Day refers explicitly to science when developing his thoughts, we adapt his notion that knowledge a scientist has can be thought of as "potentials toward expression within given situational and historical context" (Day, 2005). Scientific organizations can be viewed as especially capable and experienced in making knowledge that is tied to individuals explicit and accessible. Nevertheless, we keep the initial notation Nonaka and colleagues have introduced since the terms "tacit" and "explicit" have found their way into knowledge management literature. Summing up, for the following reasons we draw on Nonaka and Takeuchi's SECI model to describe the management of scientific knowledge:

- SECI aims at explaining mechanisms of creating an transferring new knowledge, which is the ultimate goal of science;
- Converting tacit to explicit knowledge comes close to the most central activity of researchers: writing papers and publishing new findings;
- The SECI model is widely accepted and has been applied in a number of studies and disciplines.

In Figure 4 the SECI model is applied to research in general. To explicate the knowledge conversion that takes place between researchers, a framework with two scientists is developed. For each scientist both tacit knowledge that can be explicated and knowledge already made explicit by the respective scientist is visualized. The edges between the four resulting types of knowledge (tacit and explicit knowledge of scientist A, tacit and explicit knowledge of scientist B) represent the different conversion modes. The framework is somewhat similar to the one suggested by Alavi & Leidner (2001), but kept simpler in order to avoid unnecessary complexity.

A typical process of a scientist is to write and publish a paper in order to explicate (and, in a second step, disseminate) research findings. If the information described in the paper has not been articulated before, one can denote it as new explicit knowledge. Therefore, from the viewpoint of an individual scientist, externalization primarily comprises processes of writing and publishing a paper. In contrast,

socialization describes activities of transferring tacit (not yet explicated) knowledge between scientists. Such informal communication for instance takes place at research group meetings or conferences – excluding watching presentations of proceedings articles. The latter case falls into the category of internalization, which in the field of science normally means reading and understanding work of colleagues. If scientist A reads and understands the work of scientist B, he/she converts explicit knowledge of scientists B into tacit knowledge. The fourth conversion mode is combination. Combined explicit knowledge of different scientists normally can be found on the journal level. For instance, the compilation of a specific journal issue (or a specific sub-category of a repository) represents a combination of explicit knowledge. Citing other's work can also be seen as a process supporting the combination mode. When looking at the reference list of a paper (or the "cited by"-list of scientific search engines), the reader may benefit because of preselected, potentially useful information. In that case the combination has taken place on the individual level.

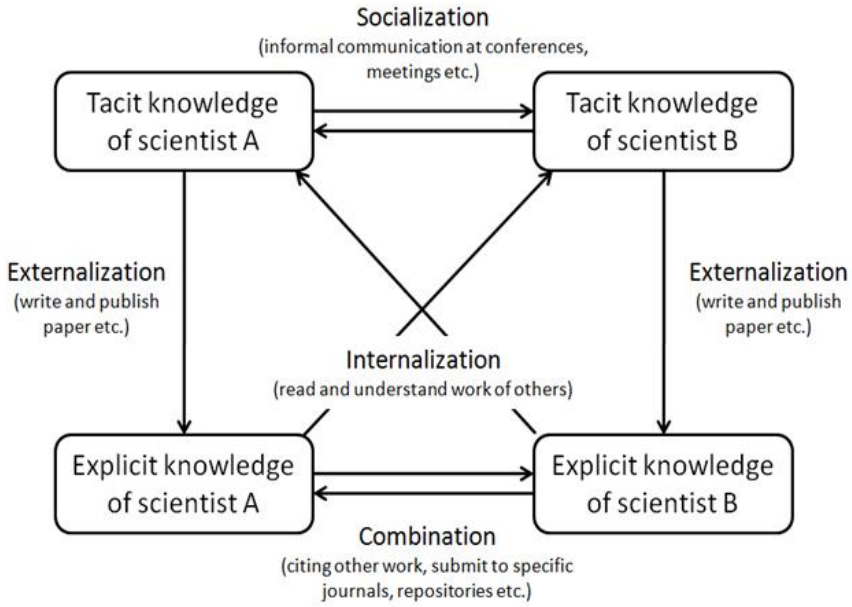

Figure 4. Processes of scientific knowledge creation.

5 INFLUENCE OF OPEN ACCESS ON SCIENTIFIC KNOWLEDGE CREATION

As described in section 2 the OA movement is a main driving force concerning the change of scholarly communication. A large number of papers have focused the significant and diverse changes OA has triggered. For instance, Mann et al. (2008) built a survey by which they wanted to detect the determinants of an authors' intention to use OA models. 481scientists from different disciplines (Information Systems, German Literature, and Medical Science) were included in the analysis. Concerning the performance differences between OA and traditional publication media, the results clearly show that scientists expect OA to be advantageous with regard to a wide and rapid dissemination of new findings and reaching a broad readership.

5.1 Acceleration of the knowledge creation process (epistemological dimension)

New scientific knowledge results from codification of communication that disrupts the state of the art of existing knowledge (Lucio-Arias & Leydesdorff 2007). Production of scientific knowledge is in

turn closely coupled to the circulation of scientific texts, which are normally institutionally arranged in scientific journals, semantically structured to carry meaning, and through citations linked to the existing body of knowledge (Fujigaki 1998). Although OA does not decrease the time it takes a scientist to write a paper (and therefore to articulate tacit knowledge), it positively affects *externalization* by accelerating the subsequent process of publishing the paper. All things being equal, the probability that other scientists read one's article is higher if that article is openly accessible. In this context it is important to address the issue of quality assurance of OA articles. A main argument of OA critics is that self-archived work does not adequately meet the high quality expectations of the research community – especially because peer review is missing. The key to solving this problem lies in models like the arXiv repository. As described above, scientists who deposit pre-prints of their work on arXiv additionally submit these papers to regular, peer-reviewed journals. If an article is finally accepted by a journal, the pre-print version on arXiv gets complemented by the information "accepted by…". With this approach the problem of lacking quality (or missing information about the quality) of an OA paper can be avoided. Hence, since OA increases the speed of making explicated knowledge accessible for others, it can be proposed that OA accelerates externalization.

In contrast, *socialization* is only marginally influenced by OA. It can be argued that OA supports the building of linkages between individual scientists and fosters interdisciplinary research (Awre 2002), but web-based "Science 2.0" applications and concepts like weblogs, wikis, social networks, or social bookmarking are much more effective in terms of informally transferring scientific tacit knowledge than OA (Shneiderman 2008, Waldrop 2008). Nonetheless, OA is an important prerequisite for those applications. The effect of OA on *internalization* of scientific work is also more of an indirect nature. For instance, when internalizing explicit knowledge of another author, a researcher often needs additional information to completely understand the work. If this information (e.g., other papers of the respective author or referenced articles) is OA, the process of internalization gets enhanced in terms of time-saving and thus cost reduction.

However, the influence of OA on *combination* is evident – especially when the process of citing scientific work is incorporated into this conversion mode. Several authors found a positive correlation between the state of access of an article and the number of citations it receives (Eysenbach 2006, Graig et al. 2007). Lawrence (2001) was the first to report higher citation rates for OA texts compared to non-OA articles, when investigating the citation impact of conference articles in computer science. Similar findings have been reported by Odlyzko (2002) in Mathematics and Hajjem et al. (2005) for all disciplines. Using a simulation-approach, Bernius & Hanauske (2009) demonstrated how individual authors benefit from a switch to OA by gaining more citations compared to non-OA authors. On the other hand, OA supports combination of explicit knowledge on an individual level. For instance, using a social bookmarking tool to create a personal online library is useful only if the papers combined are readily accessible. Concerning the epistemological dimension of knowledge creation we suggest the following proposition derived from the above theoretical reasoning:

Proposition 1. Open Access positively influences knowledge conversion, which leads to an acceleration of the scientific knowledge creation process.

5.2 Widening the dissemination of scientific knowledge (ontological dimension)

The dissemination of research findings is the most evident determinant of scientific knowledge transfer. As stated above, when discussing the ontological dimension of organizational knowledge creation, Nonaka et al. refer to the transfer from individual to collective knowledge and vice versa. In case of the scholarly communication system, it can be differentiated between an individual scientist, a research group (e.g., a team of three or four scientists involved in a specific research project), and a research community (e.g., all researchers in the field of Information Systems in UK). OA increases global accessibility of scientific knowledge. For instance, publishing articles according to the OA paradigm enables scholars at universities with a relatively low budget for licensing journals to access more scientific literature. Thus, OA contributes to bridging the digital divide between developing

countries and developed countries (e.g., Ahmed 2007). In contrast, the traditional publishing system restricts knowledge dissemination through access barriers. Higher citation rates of OA articles are also indicators for an improved dissemination of scientific knowledge. Hence, we suggest the following proposition concerning the influence of OA on the ontological dimension of knowledge creation:

Proposition 2. Open Access positively influences the dissemination of scientific knowledge by increasing the number of potential receivers.

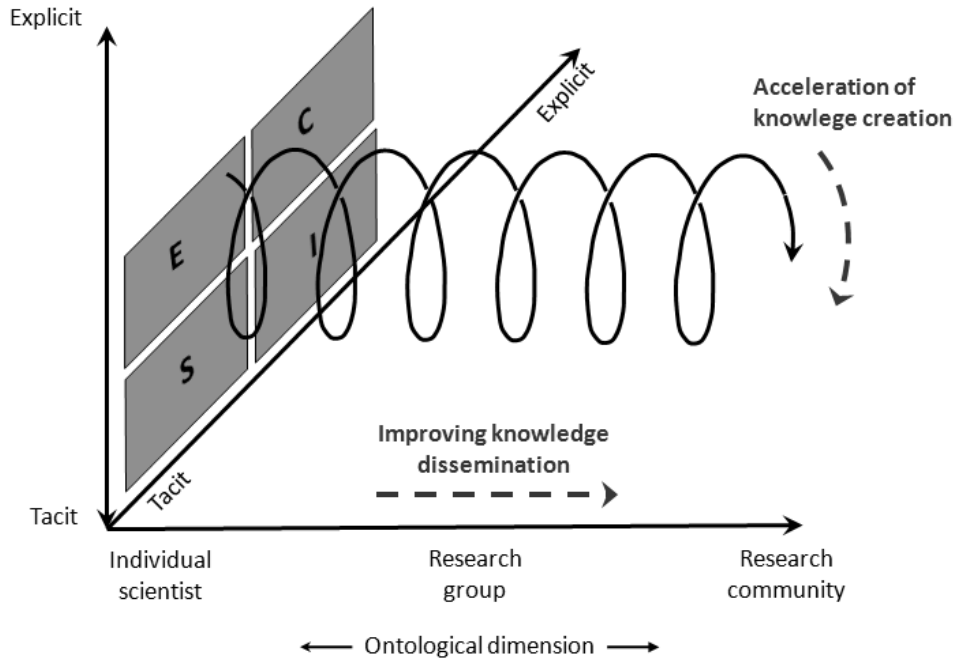

Figure 5. The effects of Open Access on the creation of scientific knowledge.

Figure 5 depicts those findings. The x-axis displays the ontological dimension of knowledge. The influence of OA becomes manifest in an extended research community. The y- and z-axes are used to depict the SECI-matrix (epistemological dimension), whose modes are run through repeatedly while widening the knowledge level. As described above, OA leads to an acceleration of the resulting spiral.

6 CONCLUDING REMARKS

The goal of this conceptual study was to analyze the influence of OA on scientific knowledge creation. By applying the theory of organizational knowledge creation of Nonaka and colleagues to the processes of scientific communication, a conceptual framework was developed that assigns typical activities of the research process to the four SECI knowledge conversion modes. On the basis of this framework, different effects of OA on scientific knowledge creation had been explicated. In summary, we proposed that on the one hand OA increases the speed of running through the knowledge creation spiral, and on the other hand OA increases the number of potential receivers of explicated knowledge and thus fosters dissemination of new findings. Whereas traditional publishing keeps knowledge creation going, but slows it down (especially when looking at the time span between submission of an article and publication), OA models – if realized broadly – have the potential to significantly improve scientific communication.

Against the background of these propositions, we finally want to focus on practical implications for "knowledge managers" (Nonaka 1994) – e.g., how should universities deal with OA approaches? At first glance, the answer seems to be simple: Research benefits from OA, universities benefit from

productive researchers – so, the university has to promote OA. The question is how to do so. As described above, most researchers lack individual incentives to publish their work in terms of OA models. Furthermore, many commercial publishers make use of their market power to constrain a broad realization of OA. For them, maintaining the status quo is – at least in the short term – incentive-compatible, because their primary product still is "access to journals" (Bernius et al. 2009). Hence, adopting deposit mandates that require researchers to self-archive their publications in repositories is a promising way to foster OA. By mid September 2009 about hundred universities and research institutions worldwide have adopted such Green OA mandates. In most cases, authors are prompted to deposit their articles in OA repositories, so that their work is freely available online. Finally, supporting OA does not solely benefit academic research; it will also prove advantageous for transferring scientific knowledge from academics to students – is it through easing the access to literature for a master theses or supporting the provision of additional online information for a course.

Furthermore, while our results contribute to the theoretical foundation of OA advantages, the conceptual framework as well as the propositions we draw would provide a valuable starting point for further theoretical and empirical research. First, it should be analyzed if and how alternative theories of knowledge creation are suitable for accomplishing the research goals of this paper. Second, our findings should be empirically validated, for instance through conducting a survey of researchers in order to evaluate the causal relationships derived of our analytical conceptual research.

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