

## Re-conceptualizing the digital divide: a knowledge-based approach.

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### Abstract

*Determining a robust conceptualization of the digital divide has proved to be a difficult challenge for scholars. This paper argues that a knowledge-based approach provides an effective means to understand and develop responses to various forms of disadvantage related to access and use of Information and Communication Technologies (ICTs). In developing this idea one area of social network analysis is used to make the claim that social networks are used by people to configure an ontology to negotiate the uncertainty of their day-to-day existence. It follows then that digital divide factors can be understood in terms of ICT facilitated knowledge development and related processes. The paper investigates this idea by using Nonaka and Takeuchi's knowledge management framework to analyze five case study examples.*

### 1. Introduction

How to best conceptualize the notion of the digital divide has represented a significant challenge to scholars for some time. While there exists an important role for information and communication technologies (ICTs) the interplay between technology and people is complex. Coming to a better understanding is arguably important if strategies to overcome the digital divide are to be effective. This paper contributes to this endeavor by developing a knowledge-based perspective of what constitutes a digital divide. Drawing on one area of social network analysis the paper develops such an approach using the literature then supported by case study examples.

In this paper a knowledge-based perspective of the digital divide is based on Callon's [1] theory of social networks. The networked nature of peoples' interactions has led Callon to describe the practical function of networks in terms of an 'ontology' that serves as a collective resource for people to draw on. The practical extension of assigning social net-

works with an ontological purpose is that networks enable people to develop, organize, share and use knowledge. As many aspects of shared knowledge development can be better achieved by ICTs a potential problem emerges in the absence of ICTs, a situation ostensibly described by the term "digital divide". In order to articulate how a knowledge-based perspective is able to address a gap in ICTs the paper explores Nonaka and Takeuchi's [2] [3] knowledge management model firstly from a theoretical perspective and then from case study analysis.

The paper begins with a brief description of how the term "digital divide" has evolved. It then moves on to describe one aspect of social network analysis that makes claims about the purpose of networks being related to the configuration of an ontology. The paper then suggests Nonaka and Takeuchi's knowledge model as a means by which a knowledge-based perspective can be used as a methodology to analyze ICT related community projects. Five case study examples are detailed to provide the reader with some insight about how effective this method is.

### 2. Evolving Conceptualizations of the Digital Divide

The term digital divide entered into common usage sometime during the mid-1990s. While the specific origins of the word are not wholly clear<sup>1</sup> official recognition of term can be found in the land mark report by the United States agency, NTIA (National Telecommunications and Information Administration), called 'Falling Through the Net: Defining the Digital Divide'. As a leading proponent of the social informatics research agenda, Kling [4] was an early critic of a digital divide concept. He advised policy makers and academics to think in terms of both physical access and social access. While the former refers to the provision of ICTs to people the latter refers to the provision of

<sup>1</sup>A list serve discussion called Digital Divide hosted by Benton Organisation delves into this topic. See <http://www.rtpnet.org/lists/rtpnet-tact/msg00080.html>.

training, teachers, instructors and help-desk personnel who can attend to the difficulties people have in using new networked services. Central to his thinking was the abandonment of the 'standard tool model' where specific change can be predicated on the deployment of ICTs. Rather he observed that ICT-enabled change is a negotiated social process where as described by Warschauer [5] 'technology in use and social worlds co-constitute themselves in [a] highly intertwined fashion'.

The study of the digital divide represents a more recent manifestation of a research problem that has been prominent for a number of decades. The connection between telecommunications and development has been an important area of study for scholars as well as organizations such as the International Telecommunications Union (ITU) [6][7]. In line with Kling's skepticism of the standard tool model described earlier the motivation for this research in telecommunications was recognition that the connection between telecommunications and development is real but not necessarily causal in the sense that the former leads to the latter [8][9]. Indeed, an economic analysis reveals that investment in ICTs may not represent optimal investments to best promote development [8][10].

A considerable amount of attention has been given to creating the right regulatory context for telecommunications to flourish. This has often led to a narrow concern with economic efficiency while the broader question of how telecommunications contributes to better outcomes in society has not been fully addressed [11]. The concept of universal service has served to identify an increasing necessity for individuals to have access to telecommunications services to enable equitable involvement in society [12]. As Miller [13] states, '[u]niversal service is the process of eliminating barriers so that everyone has the opportunity to use our evolving telecommunications systems for meaningful and effective participation in all aspects of society'. Indeed, the dangers of exclusion from ICTs may lead to serious unforeseen social and political costs that are not factored into a traditional economic cost-benefit analysis [14].

Increasing intelligence of telecommunications networks has enabled more control to be devolved from central exchanges to consumers [15]. This in turn has engendered a new and vocal constituency seeking to extend the benefits of new ICTs to more people in the community, many of them marginalized [16][17]. This is reflected in the increasingly prominent role of consumer advocacy groups within official standards setting processes [18] but is also reflected in the voluminous contributions to mailing lists dealing with the digital divide debate (see Footnote 1). As Shearman [19] quips, the potential exists for people to become 'information shapers' rather than information 'chasers'.

This enhanced vision has presented challenges to established players. Gurstein [20] perceptively points out the

bounded rationality of equipment manufacturers keen to open up new e-commerce markets in less affluent parts of the world but essentially restricting the role of "end-user" to "consumer". He claims that this has limited the scope of the digital divide debate in forums such as the World Summit on the Information Society (WSIS). He also chides some communication activists for similarly limiting debate by not understanding the transformative potential of new ICTs, which now can move people away from being passive consumers of information to active contributors to the information economy.

In summary the changing nature of ICT use has invited the involvement of a range of participants. Researchers in areas ranging from education, telemedicine, media studies, social work, information systems and so on look to the promise of multi-media technologies and the Internet for each of their area's challenges. This in turn presents additional challenge of communicating across disciplinary divides. In explaining his Community Informatics research agenda Gurstein [20] advises that a on-going dialogue be established between system planners and end-users. This two-way relationship recognizes the fact that both planners and end-users are working within the limitations of their own knowledge. On the one hand, researchers do not fully comprehend the local circumstances in which end-users reside. On the other hand, end-users do not necessarily have the knowledge and experience to guide the deployment of ICTs. To this extent there needs to be a judicious mix of technology "push" and technology "pull" where the process is situated firmly within the cultural context in which the new ICTs will be deployed.

One step to increasing participation in this debate is a broader lexicon that better captures the diversity of issues associated with the digital divide. An example of the ways new approaches can increase the conceptual tools by which to respond to the digital divide problem can be seen in Warschauer's [21] focus on literacy. According to Warschauer, literacy acquisition has many similarities to the digital divide debate as both are related to communication technology development and knowledge production. The specific ideas that this approach delivers is that:

'there is not one type of ICT access, but many; the meaning and value of access varies in particular social context; access exists in gradations, rather than in a bipolar opposition; computer and Internet use bring no automatic benefit outside of particular functions; ICT use is a social practice involving access to physical artifacts, content, skills, and social support; and, acquisition of ICT access is a matter not only of education, but also of power'.

From the perspective of those wishing to see more atten-

tion to the “demand” side of ICT use, the insights of both Gurstein and Warschauer on the digital divide are very useful from three perspectives: firstly, the focus on end-users empowers recipients of new ICTs to contribute to change that directly affects them; secondly, the emphasis given to learning is appropriate because the uniqueness of each new site of ICT deployment presents unique problems that need to be solved at a local level; and leading to the third point, the emphasis given to culture enables the potential and constraints of the broader community to be effectively incorporated in the analysis. All of these factors contribute to a more refined understanding of the ways ICTs can be used to promote more effective participation by individuals.

### 3. Social Networks in the Configuring of an Ontology

The paper moves on to consider the value of a knowledge-based perspective when conceptualizing the digital divide. The value in adopting such an approach is that it brings the analysis one step closer to the experience of end-users and their learning.

More specifically, a knowledge-based conceptualization of the digital divide draws its inspiration from the study of human-centered networks. As argued by Callon [1], people contend with the uncertainty of their daily existence by participation in networks made up of people and “things”.<sup>2</sup> Setting up the justification of a knowledge-based perspective for this paper Callon argues that the purpose of networks is primarily to configure an ontology in order to allow people to negotiate the complexities of an uncertain world. With this understanding a distinction is drawn from other branches of network analysis that emphasizes the patterns of connections that exist between nodes but downplay the influence that individuals with specific plans and goals have on network formation and function. Hence the “morphology” of networks - the contextual factors relating to the environment, existing knowledge and capabilities - is important in understanding factors that contribute to network efficacy.

The meaning of the word “ontology” requires some clarification as it has developed different meaning between its origins in philosophy and that, which is freely applied with Computer Science in relation to the semantic web and other areas of artificial intelligence. The *Collins dictionary of sociology* [23] defines ontology as a ‘branch of philosophy that is dedicated to establishing the nature of fundamental kinds of thing which exist in the world’. In its most basic form an ontology seeks to describe basic categories and relationships of existence that faithfully reflect reality. The

<sup>2</sup>The word “technology” jumps to mind here but the term can be ambiguous as some use it to refer to artefacts while others use it describe systems of uses as well as the artefacts [22].

term ontology is also used in the study of artificial intelligence to formally specify a conceptualization in a subject-predicate manner. Speaking from a Computer Science perspective Gruber [24] contends that the purpose of an ontology is to enable knowledge sharing and re-use. Gruber’s definition of ontology can be understood within the context of Callon who assigns the role of networks as configuring an ontology. For the purposes of this paper the term ontology is defined as the means by which knowledge is organized for sharing and use between people and machines.

The identification of both people and machines as active participants in configuring an ontology has both practical and theoretical import. From a practical perspective, notions of digital divide have historically been formulated on the presence or absence of ICTs. So, in seeking to promote the importance of social factors the analysis does not inadvertently extinguish ICTs from its purview. From a theoretical perspective, Callon, as a pioneer in the development of actor network theory (ANT), holds that human and non-human “participants” should be given equal recognition as influential actors in the function of networks [25][26]. Therefore, the theory underpinning this approach to the digital divide appears as both robust and appropriate.

Conceptualizing the digital divide as being related to knowledge development, organization, sharing and use within a network of people connected by ICTs attempts to capture the essence of Callon’s insight and is clearly sympathetic to the ideals of Kling’s social informatics research agenda described earlier. Exclusion is therefore not only indicated through poor access to ICTs but more accurately exclusion from collective knowledge related processes within a community.

### 4. Nonaka and Takeuchi’s Knowledge Management Model

In order to make more concrete an ontological perspective on the digital divide the knowledge management model of Nonaka and Takeuchi is investigated [2][3]. The areas defined above as important are given attention within this framework. Knowledge development represents the primary area of Nonaka and Takeuchi’s framework where considerable emphasis is given to knowledge transformations as a function of the interaction between individuals and groups. The other focus is on social context. In Nonaka and Takeuchi’s studies social context is almost exclusively focused on Japanese companies that are primarily directed at creating new product ideas.

The use of Nonaka and Takeuchi’s knowledge management framework for this research is justified because of the value that Nonaka and Takeuchi bring to the definition of various knowledge transformations processes. An assumption is made that these processes are fundamental to the way

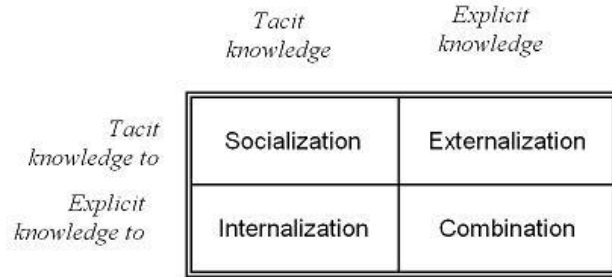
people solve problems rather than limiting these processes to Japanese innovating companies. The experience of Nonaka and Takeuchi underlines the importance that company structure and organization plays in shaping the context for knowledge creation, organization and use.

More specifically, the value of Nonaka and Takeuchi's model is that it combines ontological and epistemological dimensions into four fundamental knowledge transformations described by the terms socialization, externalization, combination and internalization (sometimes referred to as SECI). In this context, Nonaka and Takeuchi view knowledge development as comprising of an increasingly communal character where knowledge of the individual is amplified through a process of group interaction that initially qualifies the knowledge, then justifies it as being reliable knowledge for more widespread use within the organization.

The second important construct is an epistemological one that describes knowledge as having a two-part character described by its explicit and tacit attributes. As Nonaka and Takeuchi explain, explicit knowledge is 'transmittable in formal, systematic language' while tacit knowledge has a 'personal quality, which makes it hard to formalize and communicate'. The combining of the epistemological and ontological constructs gives rise to knowledge transformations between tacit and explicit forms by virtue of communication between an individual and groups of individuals within the context of an organization.

The SECI knowledge transformations indicate the nature of changes that occur in knowledge during the innovation process (see Figure 1). Firstly, tacit knowledge to tacit knowledge conversion requires a socialization process to enable this transfer to take place. Examples of the socialization process include conversations between work colleagues and supervisors, learning by copying, "war" stories and gossip. The creation of explicit knowledge from tacit knowledge can be achieved by an externalization process. Externalization is where the skills and experience of individuals are converted into documented procedures, rules and theories. Explicit to explicit knowledge transfers, called combination, refers to the reconfiguring of existing information or explicit knowledge by adding, sorting and categorizing to create new explicit knowledge. Lastly, the transformation of explicit to tacit knowledge is achieved through what Nonaka and Takeuchi call an internalization process. This is where individuals develop individual skills by applying explicit knowledge from books, manuals and procedures through a process of experimentation.

The value of analyzing digital divide projects using these four modes of knowledge transformation is that attention is given to the qualitative nature of knowledge development within a given context. Further, the nature of this increase in knowledge can be identified and qualified in relation to



**Figure 1. Nonaka and Takeuchi's knowledge management matrix**

factors that exist in the physical and social environment. In summary, the change and expansion of a community's ontology can be observed. Not only can judgments be made of the social impact this will have but also identify who best should support the expansion of such an ontology. The following examples provide an indication of the value of analyzing digital divide related projects using Nonaka and Takeuchi's framework.

### 5. Case Study Examples

Five case study examples are now described as a means to illustrate the value of Nonaka and Takeuchi's knowledge management framework for situations in which ICTs are used to overcome distance-related deficiencies in knowledge development. It is important to indicate that not all examples describe people who are economically marginalized and as a consequence would not be considered as candidates for public support. On the flip side, it is clear that the remaining examples are candidates for public support, which in itself is a useful insight for policy makers.

The first example indicates the value that ICTs may provide in the online storage of documents for people who are unable to store paper-based documents. As detailed to the author by Linda Chellew, Programme Development Manager for the Gap Youth Centre in Alice Springs, Central Australia, some indigenous Aboriginal Australian youth need documents such as CVs to obtain paid employment within the formal economy. However, the existence of furniture designed for the storage of hard-copy documents is not common within the domestic settings of many families in remote areas of Australia. In one example one young person lost his academic transcript from vocational college because an elderly grandmother, not knowing its significance, used it to start a fire for cooking. The use of ICTs in a community technology setting of the Gap Youth Centre in Central Australia has provided a viable alternative to such young people by enabling the online storage of documents.

It is anticipated that online storage of documents will go a long way to keeping and ordering important textual sources that individuals may need when participating in the formal economy.

From the perspective of Nonaka and Takeuchi's knowledge management model this activity can be best associated with 'combination' (see Figure 1). This is where explicit sources of information are organized in ways to create new knowledge. Within the context of this example the storage and ordering of explicit textual sources online enables young people to use this information to create job applications and the like when the need arises and still maintain involvement with family. ICTs are able to span this divide with a rather simple remedy that is able to resolve the contending demands of camp life and the the formal economy. The configuration of an ontology is perhaps most plainly seen here because explicit sources of knowledge are made more accessible to more people.

The second example is another instance where ICTs can be used to store and organize documents online but this time for travelers. When seeking paid work to fund further travels or to negotiate visa extensions and the like travelers are faced with a similar constraint with the storage of documents. The ubiquitous Internet Caf provides such people with facilities that allow the storage, retrieval and printing of documents. Once again this can be found to relate to Nonaka and Takeuchi's combination quadrant of the knowledge management matrix (see Figure 1) where travelers are able to organize explicit sources of knowledge despite their itinerant lifestyle.

Remaining with travelers, the third related example illustrates the way ICTs can be used in the maintenance of interpersonal relationships over distance. For travelers, Internet cafes provide another important function of providing email access. From Nonaka and Takeuchi's knowledge management perspective this is similar to the socialization process because personal information akin to tacit knowledge is being shared with other people. A degree of codification must occur in order for personal thoughts to be expressed in text so one can see the process extending beyond socialization to externalization (tacit to explicit knowledge conversion - see Figure 1). The social context is hence much more personalized than participation in the job market or negotiating a visa extension. The configuring of ontology can be seen in the way that the personal experience of travelers is communicated to family and friends which in turn forms part of the collective knowledge individuals within family groups may use on a daily basis.

As seen in the previous example, the socialization process is an important step in making common among a group of people the personal knowledge of an individual. This is also relevant to the example of young Aboriginal people living in Central Australia who need to deal

with negative stereotypes of their immediate community. As described by Programme Development Manager, Linda Chellew, one proposed activity at the Gap Youth Centre is designed to counter these stereotypes by organizing contact with youth of other first peoples in places such as the Pacific. The ability to communicate via ICTs enables associations to develop between young people who, despite their distance, have a number of factors in common. It is anticipated that interaction among such people will validate their experience and lead to the development of new areas of understanding as they explore their identity in the new "context" of the cyber domain.

From Nonaka and Takeuchi's knowledge management perspective this example resonates with descriptions of early stage innovation (socialization and externalization - see Figure 1) where personal knowledge is articulated then validated for use by the rest of the group. The social context is one that is defined by common experience of being young and of first people origin even though these individuals will have had no previous personal contact. It is anticipated that the outcomes of this exchange will make a positive contribution to the ontology shared among this group in that new knowledge is developed that is affirming of individuals' identities and background and useful for countering negative stereotypes.

The fifth example focuses on UNESCO sponsored work in linking multimedia technologies and expertise in the use of such technologies with communities in developing countries [27]. These projects are designed to address problems of those who are poor and marginalized by economic and cultural factors. Central to this strategy is Community Media Centers that focus on the provision of appropriate information that enables effective decision-making at the local level. The use of multimedia technologies broadens the scope of ICT use to include audio and visual technologies along with textual mediums. This approach recognizes that knowledge sharing and re-use is often best facilitated through the use of pictorial and oral means particularly if literacy levels are low or there is a lack of material in the vernacular. The interest that such productions illicit from local people can be profound.

This work is notable for the way it utilizes all four of the knowledge transformations described by Nonaka and Takeuchi (as opposed to single areas identified in the previous examples). The media centers focus on eliciting the personal experience of individuals and making this more explicit by way of multimedia technologies. This enables this to be shared by the group and validated as useful knowledge or otherwise. The final media product becomes an artifact of the ontology configuration process that is accessible to many people within the community. Reflecting the circular nature of Nonaka and Takeuchi's knowledge transformation process the multimedia product becomes an important

means by which this knowledge can be internalized by individuals and ideally used to create benefits in their personal circumstances.

## 6. Discussion and Conclusions

On the basis of the limited number of case studies just described this section seeks to assess the value of using Nonaka and Takeuchi's knowledge management framework in analyzing digital divide projects into the future. The selection of case study examples makes an implicit assumption that has not been addressed to this point. Projects in which no visible knowledge development activity can be observed have been omitted from the analysis on the assumption that such a project is ineffective. While this appears as a truism no evidence is presented here to support this claim.

In summary, the first and second case study examples indicate a simple strategy in which the online storage of documents can improve the ability of itinerant people to participate in the formal economy. To the extent that knowledge development is related to the organization of explicit sources of knowledge as claimed by Nonaka and Takeuchi (and supported by other innovation researchers [28]) this information management initiative has reduced one barrier to participation in broader society. The codified nature of this knowledge allows observers to perceive how such an initiative can be understood in terms of an ontology where the use and re-use of knowledge is made easier.

The third and fourth case studies demonstrate the use of ICTs to enhance interpersonal communication thereby providing an effective and efficient way to contribute to the collective knowledge of a group. The nature of such communication is in line with Nonaka and Takeuchi's socialization process. There is potential for such communication to lead to qualification and justification by a broader set of individuals as it progresses along what Nonaka and Takeuchi describe as the ontological dimension of their knowledge management model. The development of an ontology that exists within a group of people with shared knowledge is more difficult to observe but is an important step in the development of more concrete forms of knowledge as described by the externalization phases of knowledge development (as noted in Figure 1). This is where the limited nature of the case study examples leaves some ambiguity. However, one possible avenue for further research is to look for a coalescing of interest among a group as a sign of this early stage knowledge development activity.

The last example of UNESCO Community Media Centers provides an indication of the potential of integrated programs that draw on all four aspects of Nonaka and Takeuchi's knowledge management framework (SECI). Not only is it possible to see socialization processes leading

to the production of multimedia content (externalization and combination), the obvious interest and enthusiasm of recipients in these projects indicates the degree to which this information was relevant and subsequently internalized. This is perhaps indicative of an integrated set of knowledge management processes in contrast to the apparent ad hoc nature of the other case studies. From a knowledge management perspective the interrelated nature of these various activities along the ontological dimension contributes strongly to the formation of group knowledge.

It is worthwhile considering one further piece of information from Callon [1] in relation to network formation. He counters the simplistic assumption that candidates for assistance in a digital divide project are essentially "islands" awaiting connection to sources of information such as the Internet. This belies the 'primitive reality' of most people being embedded in an existing network that provides them with a store of knowledge that enables them to live with the uncertainty of their daily existence. The notion of ICTs to enable new network formation is to some extent a disruptive and unnatural process when considering human experience.

This is born out to some extent within the case study examples where there is a strong link between the environment (physical and social) and ICT use. In the first two examples the itinerant lifestyle of young Aboriginal people and world travelers presents a ready market for online document storage and retrieval. Similarly, email provides a means by which itinerant individuals are able to communicate with groups of people with common interest and background. It appears that the greater the degree to which the impetus for ICT use is driven by local environmental factors, the greater the likelihood that ICT initiatives will have a positive social impact. By way of contrast project managers who base their interventions on a fundamental assumption that target groups are essentially disconnected from networks may be misinformed. The value of Nonaka and Takeuchi's knowledge management matrix is that these interventions can be more finely tuned to respond to the particular circumstances of individuals.

Finally, what value lies in conceptualizing the digital divide as a networked phenomenon that is linked to the configuring of the ontology that people use to make sense of their world? The concept of 'ontology' is more nebulous to those who look to social networks than in the area of Computer Science where this concept is more concrete. The commonality between these two areas is the idea that knowledge can be developed, organized, shared and used. The case study examples each show instances where such processes can occur. To that extent, the concept of ontology appears to have some justification when analyzing situations of ICT use to address an area of social need.

Ascribing networks with an ontological purpose secondly indicates the importance of social context as a shap-

ing influence on network formation. Drawing on the biological origins of the word "morphology" as described by Callon, social context plays a role that makes possible the germination and development of a network of people and ICTs in their particular circumstances.

In conclusion, this paper has detailed a knowledge-based conceptualization of the digital divide. The manner in which it achieved this was by first exploring one aspect of social network analysis that asserts that networks enable the configuring of an ontology for people to use to negotiate the uncertainty of their daily existence. In order to provide a means to apply such a concept Nonaka and Takeuchi's knowledge management model was explained. The model was applied to a number of case study examples as a means to indicate its value when analyzing ICT related projects from a knowledge-based perspective.

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