SYSTEMS SCIENCE IN THE INFORMATION SOCIETY

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Abstract

The changes that we have experienced during the end of the 20th century are so extensive that it is reasonable to assume that we have taken part in a historical transition. This transition is characterized by the conversion of our materialistic culture into a new technical paradigm dominated by information technology. The industrial revolution was dependent on energy sources. Steam power, electricity, fossil fuel and nuclear power had their great importance since the production and distribution of energy are key factors for the success of the industrial society. In the information society the success factors are instead the technique for processing and distribution of information. What is most important in the new paradigm is thus not the central position of knowledge and information but rather the possibility to use these for such instruments that create knowledge, or process or distribute information. Even if network constellations between different organizations have existed for centuries, the great importance of knowledge and information has contributed to a new situation in the modern society. The digital world and the new information technology makes it possible to create geographically separated groups, virtual networks or virtual communities, where resources and activities are combined to create a result that can not be reached without collaboration, between the members of the network. Collaboration includes development and co-design and collaboration in such networks makes it possible for many organizations, companies and authorities to cope with fast technological changes. For them it is important that the collaboration works well to enhance efficiency to the different tasks. It is also very important that the members in the network can access and use information efficiently. There are many different factors influencing development and information interchange in virtual networks. Focusing on one aspect may therefore cause dissonance or inefficiency in other areas of the network. A system theory holistic approach is therefore essential to be able to study information related activities in a virtual network. Such a network is a social system that may be viewed as a human activity system according to Checkland's definition. In this paper, aspects of human activity systems are used to illuminate some characteristics of information behaviour that may be important for the activities in virtual networks. The question is also raised what really is development in the network. Sharing information is then not enough since that information already is available in the network. True development is achieved when members collaborate to find previously unknown new activities that could not have been created without co-design.

Keywords: Virtual network, solution sharing networks, collaboration, co-design, information behaviour, information sharing

Introduction

The changes that we have experienced during the end of the 20th century are so extensive that it is reasonable to assume that we have taken part in a historical transition. This transition is characterized by the conversion of the materialistic culture into a new technical paradigm dominated by information technology. This paradigm has been developed as a result of the development of information and communication technology that have created new technical possibilities to produce, communicate and organize enterprises. (Castells, 2000) The new society has been given many names, such as for example information society, knowledge society, and informational society. Castells (2000) means however that it is not appropriate to refer to the new society as *one* society. Even if different informational societies are based on informational ideas and a reconstructed capitalism, the new information technology combined with cultural, economical, social and contextual factors has not only lead to differences in the use of information technology but also to the evolution of societies with differences in social practices.

Even if the new society can be referred to by many different names, there are common characteristics that distinguish them from the industrial society. The industrial society was dependent on energy sources. Steam power, electricity, fossil fuel and nuclear power had their great importance since the production and distribution of energy are key factors for the success of the industrial society. In the new society the success factors are instead the technique for processing and distribution of information. What is most important in the new paradigm is thus not the central position of knowledge and information but rather the possibility to *use* these for such instruments that create knowledge, or process or distribute information.

Another important characteristic in the new society is the creation of different networks. When different actors on the market experience that their own resources are insufficient, they collaborate in networks to unite forces to meet competition. The digital world and the new information technology makes it also possible to create geographically separated groups, virtual networks or virtual communities, where resources and activities are combined to create a result that can not be reached without collaboration, between the members of the network. In order to cope with the fast evolving information technology, more and more networks aimed at collaboration and information sharing around IT projects are created. In such networks it is important that the collaboration works well to enhance efficiency to the different tasks. It is also very important that the members in the network can access and use information efficiently (information behaviour). In *Solution Sharing Networks* organizations share information and resources around the solution of a certain problem in the environment (Movement as Network, 2005). An example of a Solution Sharing Network is Microsoft's SSN. The network has been created to allow public-sector customers to share information during the entire system development life cycle from project inception to the evaluation of a finished project. At the same time SSN will encourage increased collaboration among government organizations and other actors such as academic institutions. (Microsoft, 2005) The purpose of this paper is to illuminate the nature of the process of information behaviour and collective learning in a Solution Sharing Network.

The reason to form such networks is as described above organizations in the network may experience certain advantages through the collaboration. Such collaboration may occur through co-design, which is described below.

Co-Design – Philosophical Influences

The origins of co-design can be traced to the thoughts of the philosopher Kant. He tried to find a compromise between the two perspectives idealism and realism by introducing "a priori ideas" by which the individual interprets the real world. (Forsgren, 2004) This is often referred to as constructivism and the thought is thus that we can not experience a phenomenon entirely objectively since we have these "a priori ideas". For example we always experience phenomenon situated in time and space. This implies that an individual always have a certain *perspective* on reality (ibid).

C Wes Churchman was one of the first thinkers that recognized the importance of co-design. He developed a knowledge philosophy (systems thinking or the systems approach). The basis for his philosophy is that we can look at the world or reality in a number of different ways and that the views can differ depending on the level of detail. It is important to notice that it is the viewer who *designs* the views, the individual is thus active in the process and individual goals may change from day to day or week to week. (ibid) Here the connection to a constructivist perspective is obvious. Constructivism states that the individual actively creates meaning through a process where impressions are compared with earlier knowledge.

The number of possible perspectives is not finite but at some point the individual must select which of the perspectives that should be implemented in the specific context or situation. Without this selection the individual can not perform an action. The selection of the most appropriate view is a design process as well as a co-process. (ibid) Here it is possible to see a movement from constructivism to social constructivism. The social character of knowledge is emphasized and the meaning of culture in the social process has a major influence. The culture as well as the social process has a great impact on the choice of perspectives.

It is however important to notice that since co-design actually is a perspective, it can not be described as the truth. Instead we can look at it as "one possible design" (ibid). It is thus not a universal solution but a perspective and weather it is appropriate or not must be determined according to the situation. Since information sharing and development in a Solution Sharing Network is dependent on collaboration and co-design, this perspective can however be used to illuminate the transformation process in such networks.

Co-Design In Practice

Co-design in practice is a concept describing a broad phenomenon, and today the concept is used within the area of information system with many different meanings and interpretations. Sometimes co-design is used for products like hardware and software.

Other interpretations of the concept are co-design of a business or an information system. (Olausson and Haraldsson, 2005)

Olausson and Haraldsson (2005) present three strategies for co-design of computer systems. The first involves the clients where more than one actor (subject) is involved in the activity. The second strategy instead involves more than one object that is for example that more than one system is designed at the same time. The third strategy is the combination of these two strategies. In this paper the perspective on co-design focuses on development, which is several actors (subjects) collaborate to create solutions for problems (objects).

Co-design is thus one way of illuminating the collaboration in a Solution Sharing Network. Another perspective that can be used to understand the interaction in a Solution Sharing Network is the concept *information behavior*.

Information Behavior

The base for the research about information behavior can be regarded as a collection of models intertwined by mutual dependencies (Wilson, 1999). There are however many definitions of the concept. Johnstone et al (2004) define information behavior as an observable part of human information processing, that also includes internal cognitive processes that not necessarily result in observable behavior. Taylor (1991) instead means that information behavior is the sum of the activities leading to the usefulness of information. Davenport (1997) regard information behavior as the way a human being approaches and handles information which include information seeking, information use, information processing, information sharing, information storage and even ignoring information. These definitions show that intrapersonal communication as well as external behavior in connection with information processing (including interpersonal communication) are included in the concept.

A central concept from the area information behavior in relation to Solution Sharing Networks is *information sharing*.

Talja (2002) describes in her study three types of collaboration in relation to information behavior in academic groups. The classification illuminates the contextual factors that can influence information sharing. Information sharing can be

- strategic: information sharing is here a conscious strategy to maximize the efficiency in the group. (ibid) It is here possible to see a parallel to Solution Sharing Networks. The starting point is strategic information sharing. The activity is influenced by a conscious strategy for information exchange that aims at solving different problems related to design solutions.
- paradigmatic: information sharing is here an instrument for establishing a new research area within a certain discipline or between several disciplines. (ibid) It is possible to bend the definition of paradigmatic sharing to fit the interaction in Solution Sharing Networks. Sometimes the network expands its area of interest and starts developing solutions of another type than previously. That could be

compared with academics establishing a new research area. In Solution Sharing Networks however, focus is on pragmatic use of information, that is the development and use of solutions in practice. These solutions are based on research in academic institutions. In my opinion paradigmatic sharing is not a central activity in Solution Sharing Networks.

- directive: information sharing between teachers and students (ibid). This can be seen as information transfer between an expert and a learner. I think that the relationship between strategic and directive information sharing can be expressed in terms of macro and micro levels. Strategic information sharing represents macro level – the network has been established to solve problems for all network members within an area characterized by fast development, whereas directive information sharing represents micro level – information sharing occurs to enhance the knowledge of one specific network member.
- social: information sharing as a social activity that contributes to building and retaining a certain group. (ibid) Social information sharing is important in all groups – also in Solution Sharing Networks. A specific characteristic of this kind of information sharing is that it is not aimed at a specific goal (Erdelez & Rioux, 2000 in Talja, 2002).

Information sharing thus exits on many different levels. One aim of information sharing is learning and development that also can be illuminated by Vygotsky's and Engeström's theories that are described below.

A Perspective on Learning and Development

The cognitive perspective identifies learning essentially as a story of progressively enlarged capacity for internal processing of information (Engeström, 1987). There is however a problem with the cognitive approach that must be elaborated. Cognitivists mean that the mental models of the individual are changed or enhanced or that new models are constructed. The result of this process is more complex mental models. But is it really possible for a structure to generate a new structure that is more complex than itself? How can a thought of act of consciousness create a more complex thought or act of consciousness? This problem is called Bereiters paradox of learning. (Engeström, 1987) A possible explanation may be found using Vygotskij's (1986) theories. Even if more complex structures cannot be found inside the learner, they are present in his or her surrounding world. These are acquired through interaction with other people who help the learner to do things that he could not do alone. The activities that the learner in this way takes part in will enhance the mental models in a way that makes it possible for the learner to continue independently – the social action is a prerequisite for the individual action. (ibid)

Vygotsky thus criticized the mentalistic tradition in that it tried to explain consciousness by the concept of consciousness itself. To be able to explain consciousness Vygotsky said that the explanatory principle must be based on other parts of the real world. He suggested that socially meaningful activities could play such a role. (Kozulin in Vygotsky, 1986) For Solution Sharing Networks, some of these activities could be related

to development concerning the mutual interest that was the basis for forming the network in the first place.

By adopting a cultural way of thinking and acting the human being changes his or her psychological functions such as memory, perception and thinking. (Hydén, 1996) Those functions are called the lower mental functions that through psychological tools (that are internally oriented) are transformed into higher mental or cultural functions (Kozulin in Vygotsky, 1986) The constructive principle of the higher mental functions lies however outside the individual, in psychological tools and interpersonal relations. (ibid) In that way the human being learns to perform individual actions through performing actions together with other people (social activities). The learning individual thus *internalizes* the more complex structures. The psychological development proceeds like this from childhood when the child learns the communicative meaning of an action through others. Higher mental functions can thus be seen as products of *mediated* activity. (Kozulin in Vygotsky, 1986) The difference between what the person can perform himself or herself and together with other people is called the proximal development zone (PDZ) (Vygotsky, 1986).

Yrjö Engeström (1987) builds on Vygotsky's theories. Engeström identifies two main problems within the social psychological area. The relation between learning and development respectively the relation between individual development and the development of the society. To study the relation between learning and development, Engeström uses Bateson's learning theory. According to Bateson every learning process includes what he calls deutero-learning, that is to learn to learn. His theory also includes three components: the learner, the result or the object and the instrument or tool that is used to achieve the result. Bateson's theory can be summarized in a hierarchy with the following levels (ibid):

- *Zero learning*: A subject has a specific response to stimuli, often what is called conditioning. This can be related to the behaviourist perspective. There is no possibility or ambition to adjust or correct an erroneous behaviour. Zero-learning means thus only that the individual reacts in a specific way in relation to a stimulus. (ibid)

- *Learning I*: Learning on this level means a change of a specific response to correct erroneous choices of different alternatives. On this level an organism should adapt to external condition by correcting the way an organism uses a tool. There is a specific, correct procedure that must be learned. Here there are two given components: the result and the tool. The instrument is thus on this level called a *tool* and it can consist of a generalized set of unconscious operations (internal and external) of the learner. (ibid)

- *Learning II:* Learning on this level means a change of the learning process: the alternatives in Learning I are changed and in that way the process Learning I is controlled. This means that Learning II follows after Learning I. In its most basic form it creates a change of the alternatives of the tool in Learning I. On this level the word *instrument* is used instead of tool. An instrument is thus a meta-tool, which is

a tool for handling tools. When the tool has been changed, learning is continued according to Learning I and is later returned to Learning II when there is a need to change the tool again. An example of Learning can be when an individual finds another solution on a mathematical problem. (ibid)

- Engeström identifies two different kinds of Learning II: a – reproductive and b – productive. In the reproductive alternative (IIa) the result is given and the tool is found through trial and error, that I a blind serch among previously known possibilities. The difference between this level and Learning I is, that the tool in Learning I contains fixed alternatives whereas the instrument in Level II may develop and change the tool in Learning I. In the productive alternative (IIb) the result is still known, but the tool does not exist from the beginning, but is invented or constructed through experiments. There is thus from the beginning *no* tool that can lead to the result. Therefore such a tool must be invented or constructed. It may seem as if Learning IIb is a really sophisticated learning activity. But on this level it is only possible to find a solution exactly for the prevailing context. It is not possible to find a solution that does not correspond to the limitations or possibilities available in the context. (ibid)

- *Learning III*: On this level the process that has been used in Learning II is changed. The individual learn to control the process in Learning II and create a change in the available instruments in Learning II in the alternatives available in Learning I. This level is a product of so called *double binds* in Learning II, that is a person receives contradicting messages of what happens in a situation. To solve the contradictions the process in Learning II must be expanded so that new alternatives for the tool in Learning I can be found. Learning III requires consciousness and reflection and is therefore a typical human development level that can not be found among other species. On the level Learning II the subject is presented with a problem that must be solved. On Learning III the subject must sometimes create the real problem but always reflect over the contradictions, and create new alternatives. (ibid)

Using these learning levels it is possible to reflect on the relationship between learning and development. Engeström argues that even if some people regard Learning I and Learning II as Learning and Learning III as development, that perspective could be misleading since Learning I and Learning II always are embedded in Learning III for humans. Learning III will solve the contradictions present in Learning II by developing new social activities. Therefore development can only exist as a result of learning (Learning I and Learning II), but development is also necessary for real learning. (ibid)

The second problem, the relation between personal development and the development of the society, is actually a problem of avoiding a sharp distinction between individual and society. Engeström concludes that the individual is a co-creator of cultural development and society development and thus creates only indirectly his or her own environment (since other people also contribute to the development of society). Individual development goes via societal development and the individual contributes to that development. It is therefore a dialectical relationship between the individual and societal development. (ibid)

Vygotsky saw the proximal development zone as mentioned above as the distance between what an individual can do by himself and the actions that the individual are capable of doing together with other people. Engeström, however, would like to put more emphasis on *collective* knowledge and he therefore rephrases Vygotsky's definition: The zone of proximal development is

> *the distance between the present everyday actions of the individuals and the historically new form of the societal activity that can be collectively generated as a solution to the double bind potentially embedded in the everyday actions.* (ibid)

This definition stresses the result of Learning III that is created as a solution of the double bind. He also means that in our daily life such situations must often be solved. It is also important that the society develops new activities.

Engeström makes a distinction between *social actions* (as described by Vygotsky) and *activities* which can be seen as a larger component. The latter can include several individual actions as well as social actions. Activities can also explain *individual actions* where the purpose otherwise would be difficult to visualize.

Engeström sees production through the division of labour as the most specific difference between man and other species. Production is performed through social activity systems. The most advanced and expansive form of learning is therefore the creation of new activity systems. (ibid)

In a Solution Sharing Network information sharing is a central activity. It can also be stated that some communities have been created as a result of a double bind. Some authorities may experience a demand from the central government to create solutions. The tools that they have in Learning I may for example lead to a solution that do not meet the demands from the central government and they can find no way to meet those demands on their own which creates a double bind situation. The solution to that problem can be to invent new activities through collaboration in a Solution Sharing Network. According to Engeström's (1987) theory, development in a virtual network should aim at creating new social activities that expands the network and its knowledge. Information sharing is thus not sufficient in a Solution Sharing Network but it is also necessary to produce new knowledge for development.

To further elaborate information sharing and development in a Solution Sharing Network, a systems science perspective can be used. Such a perspective is described below.

Human Activity Systems

There are many different factors influencing development and information interchange in virtual networks. Focusing on one aspect may therefore cause dissonance or inefficiency in other areas of the network. A system theory holistic approach is therefore essential to be able to study information related activities in a virtual network. Such a network is a

social system that may be viewed as a human activity system according to Checkland's (1999) description that can be summarized by the acronym CATWOE, where

- C= Customer, who is the person who will benefit from the activity or those who are influenced by the activities in the system (ibid).

  The definition of customer can be used on an individual level as well as on group level.
  In a Solution Sharing Network the customers are those who experience and take advantage of the added value that is created by the system, that is those who can take advantage of an efficient information exchange. To find further nuances in the context, it might be possible to extinguish between "expected customers" and "actual customers". The first category consists of all members in the network who can be expected to take advantage of the information interchange whereas the actual customers are those who in reality experience this advantage. This distinction indicates that some members are providers and other members are more of consumers of information in the network. Even if this in some respects may be connected to Vygotsky's proximal development zone the distinction can however in a practical situations have little value since social interaction always may create an added value for all involved.

- A = Actors, those individuals who perform the activities or those who cause the activities. The focus is here on the transformation process. (ibid)

  The actors are those who interact and share information in the network. In reality the concept of actor is not homogenous. Different actors can be differently involved in the transformation process.

- T = Transformation, consisting of the means that transform input into output (ibid).

  In a Solution Sharing Network input to the transformation process is the individual people and their level of knowledge. The supporting computer system also contribute with information to the input.

- W = Weltanschauung (= world perception), the perception of critical concepts related to the activity (ibid).

  The world perception influences the information behavior and information sharing and can be connected to different *perspectives* as indicated in co-design. In a Solution Sharing Network world perception is created both by a design process and a social process where different perspectives are perceived. At last one or more perspectives are chosen as a base for the activities that initiate the transformation process.

- O = Ownership, that is the organizational body that has the ultimate power and ambition to change and continue the activity. The owners talk *about* the system whereas the actors are located *in* the system. (ibid)

The influencing force can of course have different characteristics. The owners can supply the system with technical support that influences the transformation process, but they can also administer laws and regulations.

- E = Environment, the factors in the surrounding world (context) that could influence the activity. (ibid)

  An example of an environmental factor can be the national and international laws and regulations that controls the transformation process.

An interesting fact for Solution Sharing Networks is that a specific member can have several different roles according to Checkland's classification. A member can be a customer, that is benefit from the activities at the same time as the same member is an actor and even possess decision power to change and continue the activities, that is to be seen as an owner.

A Model of Information Sharing and Development in Solution Sharing Networks

The model shows information sharing and development in a Solution Sharing Network. In the transformation process that aims at strategic information sharing (a conscious strategy for maximizing the efficiency in the group) different actors collaborate through a computer system to create solutions to design problems. The computer stores and distributes the information that is present in the community.

It is possible that one specific actor at the same time can be owner and/or customer according to Checkland's terminology but those roles are not focused in the model. The actors are also connected to an organization with its specific constraints and formal structure that may have an influence on the actions of the individual actors. Individual actors may come from the same organization or from different organizations. Every actor is also influenced by an environment that includes previous experiences, individual knowledge and cultural restrains.

The actors use the activities and the information available in the community to solve different problems. That can be seen as learning II according to Bateson. Sometimes it is also necessary to consult experts who possess knowledge that the actual actor does not have. This leads to learning from the proximal development zone according to Vygotsky. This can be seen as directive information sharing.

Sometimes an actor can find that a situation occurs when it is impossible to solve the problem using the activities that are available in the community. What Bateson calls a double bind has occurred. To handle this situation, the member may interact with other member(s) in co-design to create a new activity that solves the double bind. This new activity is then made available to the community as a whole. This is learning from the proximal development zone according to Engeström.

Social information sharing can be regarded as present in all activities in the network. World perception is an important base for this kind of information sharing as well as in all other types of information sharing and development.

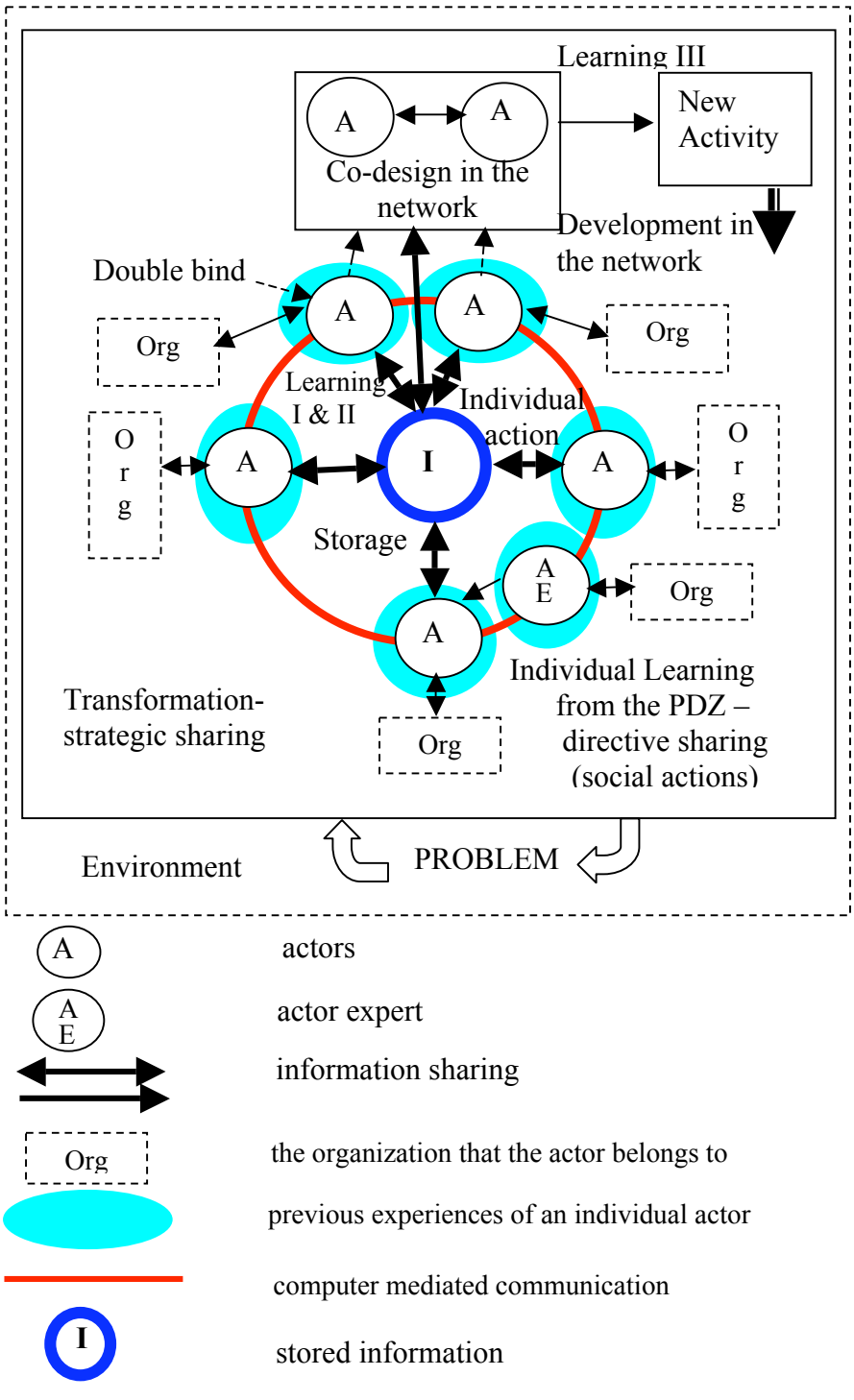

Figure 1: The transformation process in a Solution Sharing Network

The result of the transformation process is all the time compared with the demands from the problem and the process continues until the problem is solved or it is obvious that it is not possible to solve even if new activities are introduced. There is a cybernetic loop between the transformation process and the problem. The problem is however not static but is influenced both by the environment and by the transformation process in itself.

Conclusions

In this paper the nature of the process of information behaviour and collective learning in a Solution Sharing Network has been illuminated. Sharing of information may occur on different levels. The main purpose of the transformation process is strategic sharing but also other types of sharing occur within the network.

Individual actors may learn through directive information sharing, that is learning from the proximal development zone (PDZ) according to Vygotsky. Even if this is a two-way communication process, it is the knowledge of one individual that is communicated to the other. But true *development* can not occur through directive information sharing since this kind of information already is available within the network. For development to occur, it is necessary to develop new activities through co-design where different actors collaborate to reach results that can not be reached using only one actor perspective. Co-design can be understood from a systems science perspective, where the new activity has been created through social interaction leading to something more than the sum of the individual actor perspectives. This is what Engeström calls the proximal development zone.

The reason for development is that double-binds occur in everyday actions. This can be seen as problems but in this case problems are not seen as something entirely negative but as a basis for development. Reflection is however necessary to solve these problems and therefore possibilities for reflective thoughts, such as for example brainstorming or group discussions should be introduced.

The model presented in this paper can be used to create an understanding for the interaction process in a Solution Sharing Network. This understanding can be important both for designing computer systems and the social practices in such networks.

In the information society an increasing number of networks aiming at strategic information sharing are formed. A system perspective is appropriate to both understand and explain information sharing and development in such networks. Systems science is therefore of great importance in the information society.

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