UNDERSTANDING KNOWLEDGE CREATION IN CONSTRUCTION: ACTIVITY THEORY AS AN ALTERNATIVE APPROACH

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Organizational learning is widely acknowledged as being key for businesses to improve their competitiveness. It has attracted researchers from different disciplines and in the Construction Management domain various authors have also investigated learning and innovation events. Some authors have relied on the SECI model by Nonaka as starting points for mapping such knowledge creation in construction. An alternative approach to understand learning, the Activity theory, is presented. Activity theory has its origin in Russian psychology and was firstly applied in education, but is more and more used to describe team and organization based learning. Since it regards human activities as socially created and historically embedded it allows for an alternative social constructivism perspective on learning and knowledge creation within the construction sector. Previously identified publications using the SECI model are re-analyzed and synthesized using the Activity theory. While not all publications allow for a conclusive assessment due to a lack of details on reported learning events, some first observations on the suitability but also limitations of the Activity theory can be made. Activity theory might be of use for a better in-depth understanding of particular learning events.

Keywords: learning, organizational learning.

INTRODUCTION

Knowledge is an important ingredient in any company's success; its competitive edge is dependent on the company's ability to acquire and create new knowledge. Much research has gone into the fields of knowledge management, organizational learning, the learning organization and organizational knowledge (Easterby-Smith and Lyles 2003), ultimately aiming at understanding and improving knowledge within organizations. In the construction management domain the topic of knowledge has not gone unnoticed. Scholars here have investigated knowledge management as well as innovation practices in various settings. The organizations under scrutiny involved any construction related discipline, from designers to contractors. Knowledge creation and innovation has seen some particular attention over the last decade and various theoretical frameworks, derived from the mainstream management domain, have been deployed to explain observations made (Martin and Root 2009). Deployed theories such as the loop-learning model by Argyris and Schön (1978), the learning by

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experience approach by Levitt and March (1988), and the recently particular popular SECI model by Nonaka (1994) take an organizational learning approach to innovation and knowledge creation. Here the focus is typically on the organization, its routines and settings, and how these shape the company's ability to create new knowledge.

Companies in the construction industry see themselves in constantly changing environments. The project-based nature of construction with its changing role-players (architects, engineers, contractors, subcontractors) makes construction projects temporary organizations, in which knowledge is created and exchanged on various levels. Theories on innovation, knowledge creation and exchanges, and thus learning, in construction projects need to address these circumstances. Existing theories are able to explain these circumstances, as shown by many contributions by construction management researchers; however an alternative theory has long been overlooked.

The Activity theory, with its origins in Russian psychology, offers a new perspective on innovation, knowledge creation, exchange and learning in construction. Using existing publications relying on Nonaka's work to explain investigated knowledge creation events, as one sample of theories in the field, some alternative explanations are presented. This alternative understanding of knowledge creation processes in organizations might assist researchers to analyse observed behaviours and events better in future.

ORGANIZATIONAL LEARNING AND KNOWLEDGE CREATION

Overview of currently used theories

Organizational learning in the management research discipline essentially deals with ways for companies to improve their current work processes. The wider organizational learning domain thus includes matters of innovation and knowledge creation in companies. Work here is characterized by an emphasis on theory and organizational processes (Easterby-Smith and Lyles 2003). Various established theories can be deployed to explain learning processes within organizations. For instance the loop theory advocated by Argyris and Schön (1978) focuses on improving existing processes, by querying underlying processes (double loop learning) as opposed to only addressing recognized faults in a superficial remedial manner (single loop learning). Change of human behaviour from what they label a Model I to a Model II behaviour, addressing underlying processes as opposed to simply rectifying the obvious, is at the core of their theory for improvement. As such this theory describes internal review exercises aiming at improvements, yet actual learning of uncovered new knowledge finds little attention here, and the work can be described as conceptual (Engeström 1999). Similar to this is the theoretical approach developed by Levitt and March (1988) focusing on learning by experience. Creating knowledge is here understood as learning over time from history. According to Levitt and March companies create routines, in which knowledge is embedded, based on their experiences.

A third and widely used theory in the field of organizational learning was developed by Nonaka (1994) regarding knowledge creation in companies. This theory was later expanded by work of Nonaka and Konno (1998). These authors emphasize the difference in knowledge (tacit vs. explicit) and the importance of sharing knowledge within groups. They derived a spiral model of knowledge creation with four stages: Socialization, Externalization, Combination, and Internalization. Due to these processes knowledge experiences a change from tacit to explicit and back to tacit in this spiral. While through Socialization knowledge remains in its tacit form, yet is

shared, in the Externalization stage tacit knowledge is made explicit. This explicit knowledge is then combined with other explicit knowledge through combination. In the next stage, the Internalization stage, knowledge then gets converted into tacit knowledge again, which can then be socialized again later. Activities and processes within each stage have a particular setting, the corresponding Ba (Japanese for place or space, meant to describe physical but also mental circumstances). Nonaka's and his colleague's work aims at describing how an individual's knowledge gets transferred onto an organizational level, thus influencing individuals within the organization again. Important to this theory is the knowledge conversion processes in which firstly tacit knowledge becomes externalized and secondly explicit knowledge gets internalized and made tacit again. Nonaka and Konno stress that these knowledge transformations are dependent on interactions among players. However, the interaction itself and the way it contributes to organizational learning are not well addressed. Moreover, the SECI model appears to be philosophical and the separation of the four stages of knowledge creation possesses a somewhat artificial flavour. This casts some doubts on the empirical relevance of the model for the representation of learning processes in organizations.

Activity theory: part of the family

Here, it is argued that knowledge in organizations does not exist independently from the context in which it is created. Learning and knowledge creation are embedded in the interactions of individuals with their environment. They are shaped by their contextual characteristics and simultaneously change their surroundings. A not yet well recognized theory which underpins this argument is called cultural-historical activity theory. The cultural-historical activity theory, activity theory for short, is found on the work of Lev Vygotsky in the 1920s and 1930s (Engeström 2001). Later scholars such as Leont'ev and Rubenstein developed this theory further. Coming from a background of Russian psychology, using the writings of Marx as a starting point, Vygotsky argued that higher mental processes of individuals find their origin in societal processes (Blackler 1993). The basic concept of activity theory is that while humans first create common rules, they later encapsulate these rules, act according to these, and change these, based on them, again. The term activity in this framework encompasses many meanings. Activity is understood to be actions (of an individual) and operations (of a community), but also takes cognition of its surrounding society and culture. Activity is seen to be existing in a tension-matrix (activity system) made up of tools, rules, and division of labour as its corner points (Engeström 2001); all of which can be connected to the object, subject and community in which the subject acts. Blackler (1993) identified five key aspects to activity theory. Firstly, people do not just think, they act within communities. Secondly, mediating mechanisms (tools, rules, languages…) change relations between actors and within communities. Thirdly, newcomers to activity systems learn through interactions within the tension-matrix – assumed to be highly tacit. Fourthly, activities are evolving over time. And lastly, the tension articulated through inconsistencies and conflict within the activity system is at the core of the theory as this is the driving force for learning.

Individuals, or rather their behaviour, within activity systems are understood to be products of their own cultural-historical pasts; yet changing and adapting their respective activity systems. Rules are enshrined in organizational processes, in which tools, such as language, are used to create artefacts that can then also be traded among activity systems. Since however these rules are a product of history, culture, and essentially socialization, they have explicit but also tacit moments. The community

steers the rules based on a common understanding, enabling individuals to enact these according to their own interpretation. For individuals to capture the knowledge present in activity systems, the activity system itself, with its tacit and explicit rules, needs to be understood.

Using the activity theory one can thus find two simplified theoretical modes through which knowledge is created. Firstly, the actors within activity systems are seen as products and makers of their environment following rules and using tools. Through tensions within the activity system actors are forced to make sense of the given (create knowledge). Further various activity systems are existing concurrently (e.g. construction professionals with their jargon and rules, or site staff of contractors) and are getting into contact with each other (e.g. site meetings). The respective activity systems then experience some impetus, which then changes the respective activity systems again, resulting in new knowledge too.

Mirroring the activity theory against existing organizational learning theories, and particularly against the SECI model of Nonaka (1994), some crucial differences between these approaches emerge. The learning models of Levitt and March (1988), but also Argyris and Schön (1978), represent conceptual approaches and depict idealistic interventions through which organizational learning can be enhanced. Nonaka on the other hand depicts his organizational learning model based on observed processes. These processes hinge around the conversion of the nature of knowledge. Although it is acknowledged by Nonaka that knowledge always has a tacit and an explicit part, he can only create the SECI model based on the simplification that the two parts of knowledge can exist longitudinally, the one emerging from the other, which translates into learning. The activity theory however provides a tool with which knowledge in its entirety can be appreciated. Learning processes here are encompassing the full bouquet of knowledge, and a differentiation of tacit and explicit knowledge is not required; in fact using such differentiation would be contradicting the essence of the activity theory. Polanyi's (1966) stipulation that explicit and tacit parts of knowledge are always present and knowledge can only exist having both, is thus taken care of by the activity theory. Activity systems offer tacit and explicit features of knowledge floating in them.

Having introduced the concept of organizational learning, with its underlying mechanisms of knowledge creation and innovation, and having briefly sketched and evaluated the activity theory, we can assess if activity theory can be used as an alternative theory in organizational learning. Essentially the question followed here can be formulated as: Can the activity theory enhance the understanding of knowledge creation and innovation in organizations?

METHOD

From the above explanations of organizational learning theories as well as the activity theory it emerges that the mentioned SECI model and the activity theory have common features, although some processes differ. Martin and Root (2009) point out the popular use of the SECI model in construction management research. Conducting a structured literature review covering some main journals and conference proceedings in the field, they found many authors referring to Nonaka's work. In particular they identified 12 publications which engaged and made use of Nonaka's work (labelled Nonaka using contributions – NUCs), of which a mere four were seen as critically engaging with the SECI model. For an assessment of whether the activity theory offers an alternative approach to knowledge creation and innovation, this

existing work on knowledge creation and innovation using the SECI model in a critical light in the construction management domain is scrutinized.

The NUCs were read in the light of the activity theory, focusing on the roles of individuals, the nature of knowledge, the interaction of individuals and organizational learning, as well as processes described. It must however be emphasized that the nature and content of the NUCs might have been tailored around the SECI model; some data collection strategies leading up to the NUCs might have had the SECI model in mind. Re-analysing the data presented in the four identified NUCs in the light of the activity theory, some indicators for the theory's applicability can be found. Martin and Root (2009) identified four NUCs. The four NUC's were: Arif *et al.* (2009), Boonyanan *et al.* (2008), Maqsood, Walker and Finegan (2007), and Senaratne and Sexton (2008); which are used for the assessment of the activity theory. Five aspects were used to describe the NUCs.

ASPECTS FOR THE ACTIVITY THEORY

Aims

Reviewing the mentioned four NUCs one needs firstly to consider their varying aims. Arif *et al.* (2009) set out to develop a model for knowledge retention in a consultancy practice. Boonyanan *et al.* (2008) focus on the quality of relationships between project team members and its influence on knowledge management. Maqsood, Walker and Finegan (2007) portray a case study of a successful outside-in implementation of a new technology (innovation) in a company, showing the benefits of appropriate knowledge management strategies and resulting knowledge pulls. Senaratne and Sexton (2008) describe the importance of knowledge creation in relation to ongoing construction project changes. A summary is provided in Table 1.

Role of individuals

The importance of the role of individuals is well acknowledged in organizational learning frameworks (Kim 2004). The SECI model, but also the activity theory, gives some insights on the role of individuals in creating knowledge. Arif *et al.* (2009) highlight the role of individuals as knowledge carriers and starting points for existing knowledge sharing practices. Boonyanan *et al.* (2008) report on individuals interacting and participating in knowledge creation too. Here the role of seniors in creating a suitable knowledge creation environment, as well as 'apprentice-type coaching' occurring in the case studies were highlighted. The input of the former must thus be seen as more strategic, and the later apprentice-type interaction as an actual description of the knowledge creation process – here apparently situated in the Externalization stage of the SECI model. In the case study presented by Maqsood, Walker and Finegan (2007) the role of one individual is particularly highlighted. A company staff member essentially functioned as a transmitter of a product idea into a company. For Maqsood, Walker and Finegan the company's underlying values and beliefs, which also enabled the staff member to attend the conference where the initial idea for the innovation was born, play a crucial role in organizational learning. In the reported case studies of Senaratne and Sexton (2008) the role of individuals is emphasized in two ways. Firstly senior and junior individuals appear to interact in an apprentice-type fashion too, enabling the juniors to appreciate project changes better. Secondly, individuals making up teams which interact are highlighted. The actual roles of the individuals in the teams are however not conclusively discussed.

Nature of knowledge

To many authors the actual content and nature of knowledge is a crucial aspect in theory building for a better understanding of organizational learning (e.g. Huber 1991). Accordingly the four NUCs were scanned for hints about the nature of knowledge. In Arif *et al.* (2009) description of both tacit and explicit knowledge can be found. Interestingly enough it seemed impractical to differentiate between the two parts of knowledge. Reviews in forms of presentations and meeting are mentioned, with a note that these were documented. Thus both tacit and explicit knowledge appear to co-exist in these presentations. Further, a remark that older documents appeared outdated and unusable points to a non-existence of useful sole explicit knowledge. Further Arif *et al.* (2009) use the word 'idea' frequently when describing knowledge sharing situations. The notion of idea implies an explicit core, yet some fuzzy tacit knowledge still accompanies this core. Similarly Boonyanan *et al.* (2008) refer to 'ideas' too. In their case studies ideas presented in meetings were accompanied by metaphors and analogies in a bid to externalize (making tacit knowledge explicit) knowledge. Written (explicit) documents combining knowledge were observed as results from systematic interventions to capture tacit knowledge. However the use of the produced documentation in a full knowledge creation cycle appeared to be lacking in the case studies. In the NUC authored by Maqsood, Walker and Finegan (2007) the only trace of a description of the nature of knowledge is portrayed as a single item: a display at a conference, most likely entailing technical details about a building product. However in their analysis of their case studies Senaratne and Sexton (2008) emphasize the two forms of knowledge observed in the various stages of the SECI model. A differentiation between tacit and explicit knowledge is made; however, some notes appear to give away more. For example e-mails and faxes are mentioned as a communication mode during the Socialization stage; this implies that some knowledge had to be externalized at some level already. As did the other NUCs, Senaratne and Sexton (2008) recorded 'ideas' which were part of the knowledge creation process. In particular a quote (Senaratne and Sexton 2008: 1307) from a contractor points out an underlying process of knowledge creation within one single meeting only – as opposed to knowledge creation over a longer time period.

Interactions

When investigating organizational learning matters, the aspect of interactions and organizational relationships in these organizations enabling knowledge creation and learning are important to consider. Arif *et al.* (2009) report on various observed interactions. Formal programmes fostering knowledge sharing activities in the form of seminars and competitions are highlighted. Also mentoring programmes encouraging team work and vertical sharing were found. Boonyanan *et al.* (2008) highlight socializing events but also formal meetings as platforms for interactions where knowledge is 'brokered'. Innovation and knowledge creation through competitions were also observed, in which knowledge sharing was the welcome by-product. Maqsood, Walker and Finegan (2007) depict a rich picture of interactions leading up to the described innovation adoption in the case study. Interactions here are depicted on various levels within the organization, with varying linkage strength to the actual innovation adoption. They describe the matrix of the organization in terms of interlinked stakeholders which called for and eventually led to the adoption of the innovation. Senaratne and Sexton (2008) highlight various forms of interactions at the four SECI stages. Face-to-face interactions in which participants could learn and observe are highlighted. Site visits and participation in social events, similar to the

observations of Arif *et al.* (2009), are recorded. According to the data presented by Senaratne and Sexton, a listening and encouraging atmosphere in brainstorming sessions could be observed in the Externalization stage, often using sketches and drawings as aids, but also using previous projects as common points of references.

Level of processes

Through the given descriptions of the entire knowledge creation processes described in the reviewed four contributions, it becomes evident that Arif *et al.* (2009), Boonyanan *et al.* (2008), as well as Senaratne and Sexton (2008) orientated themselves on the SECI model of Nonaka (1994). While the overall processes described are linked to the SECI model, these publications also contain some hints on more complex underlying processes. Typically the SECI model seems to find its application on a higher or macro level, stretching over a longer time period. Described processes within the four SECI stages, although under one of the four umbrella stages, appear more complex. For instance Senaratne and Sexton's reference to hard-copy media to transfer knowledge during the Socialization stage are markers for explicit knowledge (according to Nonaka not to be found in the Socialization stage). Thus some processes making use of these explicit documents seem to happen concurrently with the overall socialization of the full bouquet of knowledge. The above-mentioned quote from a contractor describing a single meeting as an event of finding pathways to a final decision, placed by Senaratne and Sexton in the Combination stage, is another marker that more knowledge creation processes appear to be happening concurrently. Boonyanan *et al.* mention negotiations, supported by training, as part of the Externalization stage. Here as well, a more detailed analysis might reveal that during the negotiation process a form of socialization and eventually acceptance of opposing opinions through combination might be present too. The notion of people's ideas being valued by others, as mentioned by Boonyanan *et al.* as being part of the Externalization stage, is a further point that might require a re-analysis. Valuing someone's ideas or opinions is a process itself. It requires the acceptor to frame (combination) the respective idea and possibly internalize such idea. Thus here also on a more detailed level further processes appear to be at work. With Maqsood, Walker and Finegan (2007) only using the SECI model in their build-up for the depiction of their case study, but then relying on Soft Systems Methodology (SSM) for their analysis of the processes involved in knowledge creation, a break with the SECI model is made. The overall processes depicted by Maqsood, Walker and Finegan (2007) on a macro level are complex and inter-connected.

Table 1 depicts the above mentioned aspects against the four analyzed NUCs. This overview is simplified, as all NUCs cover far more than what is also mentioned above. However an overview is helpful to relate these publications to the activity theory.

APPLICATION OF THE ACTIVITY THEORY

Scrutinizing the various aims of the analyzed publications, it becomes clear that the activity theory could have found its application in all four cases. Activity theory with its activity systems made up of the rules, tools and division of labour matrix, encompasses knowledge retention. Knowledge is taken into communities, and its individuals are then to act upon the new knowledge again. The importance of relationships and knowledge management can be described using the activity theory too. It exists on two levels. Firstly, within an activity system individuals act. Depending on their cohesion of actions and understanding of the rules, artefacts can be mediated / knowledge created and encapsulated at varying speeds with a varying

amount of effort. Innovation adoption is a question of two activity systems meeting, using one's absorption abilities to adopt the outcome of another. As described in the case study of Maqsood, Walker and Finegan (2007) the existing rules, tools, and divisions of labour might favour rapid adoptions. They may also contradict the accommodation of new knowledge. At the core of the activity theory is the aim of describing the role of knowledge in (construction) change. The basis of this theory is that experiences make up the activity system. Thus change could also be the synonym for the above mentioned impetus of the activity system's ability to accommodate new knowledge. In describing this ability the SECI model falls short.

Table 1: NUCs and aspects: simplified overview

	Arif *et al.* (2009)	**Boonyanan *et al.* (2008)**	**Maqsood *et al.* (2007)**	**Senaratne and Sexton (2008)**
Aim	knowledge retention	link of relationships to KM	innovation adoption	link of knowledge to change
Role of individual	carrier of knowledge	apprentice-type	transmitter	apprentice-type
Nature of knowledge	ideas	ideas	explicit	tacit and explicit
Interactions	seminars	coaching	multi-level	meetings, brain-storming
Level of processes described	macro, little on micro	macro, few on micro	macro	macro, some on micro

Viewing the depicted roles of individuals in the light of the activity theory sheds some more light on the applicability of the theory to organizational learning events. In the work of Arif *et al.* (2009) individuals function as carriers of knowledge. This is consistent with stipulations of the activity theory, in which the individuals embedded in the activity systems are the actors using their understanding and knowledge. Together they make up the community which operates in unity. The fourth aspect of the theory describes the way novices get accustomed to their new environment / activity system. Through interactions within the system its rules and tools are learnt. While the activity theory did not explicitly mention apprentice-type interactions, the essence of apprentice-type learning is a guided socialization process, as mentioned by Senaratne and Sexton (2008) as well as Boonyanan *et al.* (2008). The individual being a mere transmitter of new knowledge is congruent with the notion of two activity systems meeting. However, the individual described in the work of Maqsood, Walker and Finegan (2007) is not only the connection point between two systems. The individual challenges the existing way of working and induces discussions on the appropriateness of used tools, organization processes and norms.

The notions of ideas used by Arif *et al.* (2009) and Boonyanan *et al.* (2008) for explaining the nature of knowledge, and the presentation of ideas to colleagues show clear traces of individuals acting within an activity system, introducing new artefacts based on the individual's own grown understanding. The explicit nature of the knowledge pull as described by Maqsood, Walker and Finegan (2007) can be represented in the activity system as an object giving impetus to the organization's system. And the various forms of knowledge as discussed by Senaratne and Sexton (2008) for the knowledge creation stages did show underlying processes which lead up to these forms of articulation. For example the mentioned 'pathways' in meetings leading up to decisions, are likely governed by underlying rules, exemplified by tools. Thus especially when considering the nature of knowledge brokered in the events described, activity theory could also serve as a stable means to re-create, explain and

then analyze the events leading up the mentioned seminars. Moreover, the forms of interactions mentioned by the various authors ranged from coaching to seminars and meetings. Essentially all these interactions are bundles of activities, with various actors. Companies provide the platforms for such interactions by enabling staff members to attend and supporting the concept of 'Architectural Fridays' or 'special meetings'. The organizations with their historically developed cultures are setting the framework for the activities to take place. Here activity theory offers a more thorough explanation for socialization and interaction processes than the SECI model.

Considering the levels of the processes described by the various authors, two levels must be differentiated. The typically discussed macro levels deal with how the organizations as a whole were dealing with knowledge. However further listed descriptions of processes elaborate on actual activities on a micro level. Having typically used the SECI model as starting points, the macro level approach is not surprising. What the activity theory however offers are two things. Firstly, using the activity theory the micro processes noted in the NUCs can be read in another light, linking the micro to the macro. Secondly, the influence and interrelations of the existing macro circumstance onto the micro processes can be elaborated on.

CONCLUSION

Four publications dealing with various aspects in the wider field of organizational learning have been scrutinized in terms of four key features prominent in organizational learning theories. Mirroring the respective presentations of these four features against the introduced activity theory, based on work by authors such as Vygotsky or Engeström, the appropriateness of the activity theory as yet another social constructivist approach to organizational learning is highlighted. Activity theory could be used to re-analyse the presented case studies in the respective publications. In particular, activity theory seems to be appropriate to describe micro level processes, in which individuals act and respond to situations based on given historical developments, but also changing their frame of reference. The role of individuals in organizations and their way of enacting knowledge is governed by their circumstances. Here a similarity to the Ba as described by Nonaka and Konno (1998) can be found. Yet activity theory appears to better encapsulate the underlying dynamics by linking individuals to the tools they are using, the values and beliefs they are referring to, and the community they are part of. Activity theory can also be applied for an analysis on a macro level. An activity system on this level would also have similarities to the Basho of Nonaka and Konno (1998).

Based on the above it can be concluded that activity theory may be applied to an analysis of knowledge creation processes. In particular it might prove to be of use for an analysis of micro level processes, linking these back to macro level circumstances. An example here could be descriptions of actions of individuals creating or brokering knowledge within the bounds of projects, but also across projects within organizations. Activity theory used in organizational learning research is thus undoubtedly a possible alternative, but also a complementary theory to existing theories. The multi-level nature of the organizational learning setting may well allow for differing approaches to analysis.

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