Knowledge Creation in Groups: The Value of Cognitive Diversity, Transactive Memory and Open-mindedness Norms

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Abstract: This paper contributes to our understanding of knowledge creation by developing a comprehensive model of the knowledge creating process in organisational work teams. It subsequently synthesises contemporary theory across research streams to develop hypotheses relating to three factors capable of facilitating the knowledge development process - cognitive diversity, transactional memory and open-mindedness norms. In combination, the conceptual rationale and empirical support act to substantiate three key relationships in the knowledge creation process.

Keywords: Knowledge creation, cross-functional teams, cognitive diversity, group dynamics.

1. Introduction

According to the knowledge-based view of the firm, an organization's ability to create knowledge is a source of competitive advantage (Conner & Prahalad 1996, Grant 1996, Kogut & Zander 1992, Spender 1996, Tsoukas 1996). Research into innovation and new product development provides empirical support for this perspective by demonstrating that knowledge generation is linked to new product and organisational performance (Calantone et al 2002, Cummings & Teng 2003). In view of the potential benefits accrued by developing knowledge creating capabilities, and the numerous failed attempts by organizations to do so (Dachler 1992), it is unsurprising that knowledge creation continues to be an area of research focus. Yet a review of the knowledge management literature reveals disappointing progress both theoretically on how knowledge is created (Hargadon 2002) and practically on how managers implement knowledge creation mechanisms. This paper responds by developing a comprehensive model of the knowledge creating process in organisational work teams. In addition, three hypotheses are developed and tested relating to factors capable of facilitating the knowledge development process - cognitive diversity, transactional memory and open-mindedness norms. In combination, the conceptual rationale and empirical support act to substantiate three key relationships in the knowledge creation process.

2. Knowledge creation model

This paper views the individual and group level of analysis as complementary in knowledge creation, and presents a model that reflects their dual consequence. This recognises both the general consensus that it is individuals who learn and that new knowledge in organisations is a product of its constituent individuals' learning (van der Sluis & Poell 2002), as well as the validity of social learning theories that emphasise the context of knowledge and suggest that meaning and comprehension is inseparable from its relationship to the environment (Brown et al 1989).

2.1 Group knowledge creating processes

A review of the relevant literature reveals conceptual and empirical support for a number of distinct phases in the knowledge creation process (Crossan 1999, Drach-Zahavy & Somech 2001, Gibson 2001, Jarvinen & Poikela 2001). Previous analysis of this research reveals four group processes, which in combination provide a comprehensive representation of knowledge generation (Mitchell & Nicholas 2004b).

The first process, accumulation, reflects the congress of accumulated individual inputs of knowledge that are theoretically available to the team. The idea of accumulation is extended retrospectively to include the development of knowledge within individual members' originating functional area or community-of-practice (Brown & Duguid 1991). Through extended in-depth interaction, and shared practice, members of the same functional area and, to a greater extent, community-of-practice have similar experiences and interpret those experiences similarly. These shared experiences lead to the development of shared tacit knowledge bases (Brown & Duguid 1991, Brown & Duguid 2001). The connection of segregated functional areas provides an opportunity for exchange of knowledge that is unique to each area. Unlike sources within an individual's dominant work environment, the weak ties formed in cross-functional teams provide access to novel information and tacit knowledge (Granovetter 1973).

Interaction is the second group process. Within teams, the term is used to describe the use of language and other symbols to develop enriched and shared understanding. The aim of interaction

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incorporates a desire to evolve deeper and shared understandings, which encompasses and is partly directed by the objective of boundary-spanning (Isaacs 1993). Boundary-spanning reflects the understanding that members with different backgrounds operate from different perspectives underpinned by distinct cognitive structures (Fong 2003) based on their different work-related experience (Bhatt 2000). Effective interaction relies on, and may be thwarted by, the ability to interact across the cognitive boundaries that underlie functional differences (Carlile 2002, Tsoukas 2002).

The third process is analysis, during which group members' debate points of view, assumptions and the merits of possible solutions. The group's analytical discussion impacts individual analytical processes by highlighting certain pieces of knowledge, drawing attention to faulty logic and presenting arguments in support of particular conclusions (Gibson 2001). Such reasoning facilitates creative solutions because it allows group members to link their inventory of past experiences to the current situation (Hargadon & Sutton 1997). By bringing together members from diverse backgrounds, group analytical reasoning has the potential to result in the application of a broader variety of experiences and knowledge than would be available to individuals operating alone. While the source of information regarding a previous problem or solution is the individual, the invocation, negotiation and manipulation of this information occurs through group interactions (Hargadon 1999). Group analogic reasoning builds on itself as discussion of one member's experiences prompts the introduction and exploration of further experiences from other members – one suggested previous experience shifts the groups' perspective in ways that make another seem relevant (Hargadon 1999).

The fourth process is integration and creation. The objective of this phase is the articulation of an agreed position or solution which integrates the best of knowledge available to members and incorporates new knowledge created on the basis of the previous phases. Integration and creation may be described as the externalised construction of problem solutions or decisions, involving the manipulation and integration of knowledge through debate, bargaining and agreement.

2.2 Individual (group member) knowledge creating processes

An examination of extant models evidences three individual processes that are identified as central to the process of new knowledge creation within a team. These processes occur in repeated patterns, with each process capable of stimulating another. The first individual process is transmission. The transmission process encompasses the development of an explicit representation of what is known and the interpretation of received messages through application of the receiver's tacit knowledge. In cross-functional groups, this interpretation can be described as a process of construal in which the meaning of words and phrases is investigated with the aim of converting the decoded message into a meaningful message. Members' ability to accurately interpret other member's messages is dependent on their ability to successfully apply their own mental models to message content. If an individual with tacit knowledge markedly different to the original knower is asked to interpret knowledge codified by the latter, the process of interpretation may lead to generation of a novel construal (Brown & Duguid 2001). Novel construal is an important component in the development of creativity (DeDreu & West 2001).

The second process is cognition encompassing accommodation and assimilation. Assimilation occurs as new knowledge is integrated into existing cognitive structures, and accommodation occurs when structures are altered or recreated to more comprehensively reflect new knowledge (Piaget 1969). The process of cognition also incorporates intuiting, described as the perception of patterns or possibilities in a personal stream of experience (Crossan 1999). Intuiting occurs during the process of applying tacit knowledge to new experiences, and is related to the level and depth of tacit knowledge available. A highly complex mental model, associated with the development of expertise, facilitates the perceptions of patterns that may not be apparent to novices (Crossan 1999). Within cross-functional groups, the application of complex mental models to knowledge presented from different functional areas provides an opportunity for new patterns to be recognised.

The third process is task-focused positioning. This involves individual thought processes aimed at deciding strategies and tactics. As their understanding of issues related to the task and others' perspectives develops, members prioritise, search for possible alliances and agreements, and opportunities to collaborate and/or compromise.

3. Factors facilitating new knowledge creation

The knowledge creation model outlined above provides an informative context for understanding how different group dynamics and processes may facilitate or thwart group creativity efforts. These dynamics and processes inform the construction and management of groups as knowledge creat-

ing mechanisms. As organizations become expert at manipulating these factors, their knowledge creation capability increases. In addition, as the manipulation of these factors is unlikely to be observable and likely to be socially complex, the ability of competitors to imitate or acquire this capability decreases as expertise increases. In the first step towards verifying the utility of this model, a number of propositions relating to such factors are developed relating to two of the group processes – accumulation and interaction.

3.1 Accumulation - Cognitive diversity and transactive memory

The first group process, accumulation is based on acquisition of knowledge by groups. Accordingly, the success of the accumulation phase can be understood to include the dimensions of cognitive diversity and transactive memory.

Cognitive diversity is defined as the extent to which the group reflects differences in knowledge, including beliefs, preferences and perspectives (Miller et al 1998). If accumulation of diverse knowledge is critical to knowledge creation efforts, as is predicted from the model outlined above, then cognitive diversity will increase the likelihood of creative new knowledge emerging in groups. Conceptually, this connection is primarily based on the understanding that, through the integration of diverse knowledge, groups have the potential to overcome the factors constraining the development of new knowledge imposed by the social relations into which all economic activity is embedded. This includes the institutional and task-related pressures identified by institutional theorists, which parallel the paradigmatic boundaries described by path dependency theorists, and pragmatic concerns about criticism identified by decision theorists. If new knowledge is developed that extends beyond the parameters of current functionally specific concepts it is more likely to contribute to the development of group outputs with truly novel features. Cognitive diversity may also be linked to enhanced knowledge creation efforts through a secondary mechanism. The debating of dissenting issues consequent to different approaches and perceptions associated with cognitive diversity has been found to stimulate divergent thinking in individual members, which is closely linked to creativity output (Nemeth & Nemeth-Brown 2003).

Hypothesis 1: Cognitive diversity will be linked to the emergence of creative new knowledge in groups.

The process of accumulation theoretically relies not only on the existence of a broad range of information and tacit knowledge, but also the ability to access this knowledge. Such access relies on members' knowing 'who knows what'. Transactive memory is described as a teams understanding of who has access to what specialised information within the team (Yoo & Kanawattanachai 2001). Groups with high transactive memory have good understanding of the knowledge and skills available to each individual member, and this has been found to facilitate both access to information and co-ordination. The importance of this to cognitively diverse teams relates to enhancement of group performance through the accurate understanding of the information available to the group and where it is located in terms of member expertise.

Hypothesis 2: High levels of transactive memory will increase the likelihood of creative new knowledge emerging in teams.

3.2 Interaction – Open-mindedness norms

The second group process, interaction, is based on a process of communication focusing on investigation, reflection and efforts to understand. As such, the interaction process relies on members to actively and openly listen to the information provided by others. Such an approach to communication is encompassed by the notion of open-mindedness norms. Open-mindedness norms are beliefs relating to the way in which members approach the views and knowledge of others, and incorporates the beliefs that others should be free to express their views and that the value of others' knowledge should be recognised (Tjosvold & Poon 1998). Researchers have found that open-minded interaction leads to curiousity and information-seeking when members are confronted with an opposing position (Tjosvold & Morishima 1999, Tjosvold & Poon 1998). In addition, while the majority of research undertaken on open-mindedness norms has focused on conflict and negotiation, much of this has found a strong link with information sharing and enhanced shared understanding (Tjosvold & Morishima 1999, Tjosvold & Poon 1998, Tjosvold & Sun 2003). If effective interaction is critical to knowledge creation efforts, as is predicted from the model outlined above, then open-mindedness norms will increase the likelihood of creative new knowledge emerging in groups.

Hypothesis 3: High levels of open-mindedness norms will increase the likelihood of creative new knowledge emerging in teams.

4. Method

4.1 Procedure and sample

In order to test the hypotheses, a survey study was conducted. The questionnaire was con-

structed using, for all but one construct, scale items that were developed, tested and used effectively by other researchers. In addition, the questionnaire was pilot tested with twenty business professionals and subsequently revised to ensure clarity in wording. The questionnaire was distributed with a covering letter which instructed the participants to choose a work group of which they were a member and that had at least two other members; to refer to the most recent situation in which the group made a non-routine, complex decision at work; and to complete one questionnaire themselves and request another member of the team to fill out an additional questionnaire.

Five hundred and fifty questionnaires were distributed to postgraduate management students at a university in Ireland and a university in Australia. One hundred and fifty questionnaires were distributed to eighty public sector employees and seventy private sector employees. Seventy-two questionnaires were returned completed, representing an acceptable response rate of ten percent.

4.2 Measures

Three items measured knowledge creation. All items were measured on a graphic line scale. Based on the current literature, three items were used to measure cognitive diversity. Items were scored on a seven-point Likert scale. As the measure for cognitive diversity was developed for the purposes of this research, they were evaluated using face, predictive and convergent validity assessment techniques. Transactive memory was measured using three items. All items were measured using a 7 point Likert scale. Measures were taken from a scale by (Yoo & Kanawattanachai 2001). Three items measured Open-mindedness Norms based on measures developed in previous research into conflict resolution (Tjosvold & Morishima 1999, Tjosvold & Poon 1998). All items were measured on a 7 point Likert scale. Cronbach's alpha coefficients for all four measures was over .78 suggesting that the internal consistency was satisfactory.

Group size and tenure were used as control variables as these variables have been shown to impact on the cross-functional team performance (Chen & Tjosvold 2002, Pelled et al 1999).

5. Results and discussion

Regression analysis was used to test all hypotheses. To test hypothesis 1, new knowledge was regressed against cognitive diversity.

Table 1: Results of regression analyses used to test hypothesis 1

	Knowledge Creation (Dependent Variable)
Cognitive Diversity	
Standardised Coefficient β	.33**
Standard Error	.68
Adjusted R^2	.24

**p<.01

*p<.05

The results demonstrate that cognitive diversity is significantly related to creative new knowledge, which supports hypothesis 1. This contributes to our understanding of knowledge creation mechanisms in two respects. By illustrating the existence of a clear pathway between the accumulation of a pool of diverse knowledge and the development of new knowledge, the results provide support for the model of knowledge creation outlined in the first part of this paper, particularly the role of accumulation. In addition, the explication of a rationale linking knowledge creation to the interconnection of divergent knowledge bases, coupled with empirical support, has application across several existing research areas.

The majority of extant models of knowledge creation include some reference to the prerequisite existence of a pool of diverse knowledge. While this has been theoretically justified through reference to the complexity of knowledge-creating tasks (Un & Cuervo-Cazurra 2004) and the implicit importance of diverse knowledge integration (Fong 2003, Granovetter 1973, Leonard-Barton 1995), there has been scant attempt to specifically investigate the assumed connection. This poses a number of problems. The rigour of such models remains untested and the operational mechanisms through which knowledge creation can be facilitated remain cloudy. Second, the interpretation of findings from empirical research may be stymied because foundation relationships have not been confirmed. The problem is not confined to knowledge creation research. While there has been a clear theoretical rationale underpinning the product innovation capabilities associated with communities-of-practice and some empirical evidence (Swan et al 2002), most of this research has used community-of-practice membership as the independent variable. There has been little, if any, research delving beneath the superficial community membership category to investigate the proposition that the mechanism through which innovation occurs relies upon the connection of previously disparate knowledge bases. The results of this study provide clear empirical support for the link between the collocation of a broad knowledge portfolio and new knowledge creation.

In doing so, they endorse the inclusion of the process of accumulation as a component of the model above and validate its incorporation as pre-requisite to knowledge creation in extant models. The results of this study also provide empirical support for the supposition that the link between product innovation and community-of-practice boundary-spanning is likely due first to the existence of associated cognitive variation and secondly to the existence of a facility that allows the development of some novel connections across this variation.

As well as empirical support for the connection between cognitive diversity and knowledge creation, these findings also assist in resolving a significant research issue related to cross-functionality and knowledge creation. Coupled with support for the connection between functional and cognitive diversity (Mitchell & Nicholas 2004a), these results point to the role of cognitive diversity as a mediating variable in the link between cross-functionality and knowledge creation. For organisational theorists, this reinforces the importance of cross-functional groups as mechanisms that enable the sharing and potential integration of divergent perspectives, but also cautions against the complacent use of cross-functional groupings without confirmation of associated cognitive variance.

Table 2: Results of regression analysis used to test hypothesis 2

	Knowledge Creation (Dependent Variable)
Transactive memory	
Standardised Coefficient β	.40**
Standard Error	.73
Adjusted R^2	.14

**p<.01

*p<.05

Support for hypothesis 2 was found, as the existence of transactive memory is significantly related to the level of creative new knowledge. This result contributes to our understanding of the process of accumulation by demonstrating that diverse knowledge is a necessary but not sufficient requirement for knowledge creation, and emphasizing the importance being able to access and utilize such knowledge.

The results of this study also draw conceptual connections that permit learning from transactive memory to be applied to knowledge creation theory. For example, one of the key issues raised in knowledge research is the weak performance of virtual communities in sharing knowledge (Zakaria et al 2004), which has been acknowledged as significant step in the knowledge creation process (Hargadon & Sutton 1997, Un & Cuervo-Cazurra 2004). Research into transactive memory indicates that a lack of transactive memory has a negative causal relationship with knowledge sharing (Hollingshead 1998) and is difficult to develop in virtual communities (Alavi & Tiwana 2002). Transactive memory provides a powerful explanation for barriers to knowledge creation in geographically dispersed organisations.

Table 3: Results of the regression analyses used to test hypotheses 3

	Knowledge Creation (Dependent Variable)
Open-mindedness Norms	
Standardised Coefficient β	.52**
Standard Error	.54
Adjusted R^2	.23

**p<.01

*p<.05

The regression results show that open-mindedness norms are significantly related to knowledge creation, which supports hypothesis 3. Further analysis of the data reveals that the concept of open-mindedness norms has at least three dimensions: (1) the belief that others should be free to express their views, (2) the determination to investigate and recognise the value of others' knowledge and objectives, (3) the will to utilise the best of others' ideas.

This result contributes to our understanding of knowledge creation by providing empirical support for the model developed above and, in particular, the importance of effective interaction in this process. Much of the empirical work on enhancing knowledge transfer has focused on the introduction of technological interventions, particularly information technology (Sambamurthy & Subramani 2005). The results of this study highlight the importance of psychosocial variables, in particular the norms of members, in determining the success of knowledge sharing efforts. When individual members believe in freedom of expression and value the understanding and utilisation of diverse viewpoints, their groups engage in behaviours that are more effective in creating knowledge. In conjunction with research indicating that co-operative norms are unlikely to emerge in diverse groups (Chatman & Flynn 2001), these results also warn that the absence of open-mindedness norms may pose a significant and real barrier to knowledge creation efforts, and interaction generally.

Specific investigation into each dimension of the open-mindedness norms construct (Table 4) indicates that the integration of previously disconnected knowledge through member interaction relies on the development of norms of free expression, and that determination to understand others' viewpoints increases the effectiveness of interaction efforts, and therefore facilitates the integration of disparate viewpoints. Analysis also demonstrates that the motivation to utilise the best of all available knowledge is correlated with the extent to which group members engage in debate. As debate has been identified as a vehicle through which individuals' specialised knowledge is analysed and synthesised into novel ideas (Alavi & Tiwana 2002), the identification of this connection has considerable application in knowledge creation research. It provides insight into the environment necessary for knowledge integration to occur successfully and explains the success of interventions, such as brainstorming, which explicitly require group members to consider and utilise others' diverse ideas.

Table 4: Dimensions of the open-mindedness Norms construct

	Member Interaction (Dependent Variable)	Debate (Dependent Variable)
Freely Expressing Views (Dimension One) Correlation Coefficient	.31**	.29*
Motivation to understand differences (Dimension Two) Correlation Coefficient	.67**	.61**
Motivation to use others' ideas (Dimension Three) Correlation Coefficient		.60**

**p<.01

*p<.05

6. Conclusion

This research extends the knowledge-based view by providing an explanation of how organisations' develop the capability to create new knowledge. Overall, the findings support the idea that new knowledge is created through interactive processes based on the sharing and integration of previously unshared knowledge. In particular, knowledge is dependent upon the existence of disparate perspectives. These can be understood as prerequisite tacit knowledge assets, from which explicit representations are drawn and presented to group members, and on which individual learning is built. Specifically, the results generate initial support for the model of knowledge creation under investigation. The model is composed of a series of processes at the level of the individual and group. These processes are interwoven rather than linear, and are connected through complex inter-relationships.

In addition, several specific relationships were identified as critical to the success of knowledge creation efforts. First, the integration of diverse perspectives and previously unconnected knowledge underpins the generation of new knowledge. Diverse perspectives have the potential to overcome pressures on cognitive convergence evident in individual functional areas, and in doing so overcome associated constraints on novelty. Second, psychosocial variables, in particular the norms of members, are critical in determining the success of knowledge sharing efforts. When individual members believe in freedom of expression and value the understanding and utilisation of diverse viewpoints, their groups engage in behaviours that are more effective in creating knowledge. In assessing the value of these findings it is important to remember that the existence of different viewpoints, which is necessary for new knowledge to emerge, has long been identified as a source of interpersonal conflict due to social categorisation. To conclude, this study both contributes to knowledge of group decision-making and group processes by outlining how cognitive diversity, transactive memory and open-mindedness norms are likely to impact on the creativity of outcomes, and draws implications for the knowledge view of organizations, particularly the mechanisms through which new knowledge is created.

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