Distributed Cognition in Online Generative Collectives: Enabling Collective Generative Capacity through Reflections, Interactions and Representations

Wietske Van Osch
Information Management, University of Amsterdam, East Lansing, MI, United States., vanosch@msu.edu

Hanneke Stellink
Information Management, University of Amsterdam, East Lansing, MI, United States., hanneke.stellink@paconsulting.com

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Wietske van Osch
Michigan State University
University of Amsterdam Business School
VanOsch@msu.edu

Hanneke Stellink
PA Consulting Group
University of Amsterdam Business School
Hanneke.Stellink@paconsulting.com

ABSTRACT

Analyzing online group activities against the backdrop of an increasingly connected world, this empirical paper extends the concept of "distributed cognition" as a theoretical lens for explaining why some Internet-based collectives are more generative than others. These so-called Internet-based generative collectives—groups of people with shared interests or goals who mutually engage in generative acts—evolve around three processes of distributed cognition, namely reflection, interaction, and representation. Using Q-methodology, the relations between these three dimensions of distributed cognition and the generative capacity of Internet-based collectives is explored. The findings of a Q-factor analysis reveal that processes of distributed cognition lie at the heart of generative collectives. Furthermore, depending on how enabling the underlying structure and available technology of a collective is, an environment emerges in which the processes of interaction, reflection, and representation can flourish, thereby maximizing the collective's generative capacity. Finally, implications for practice and future research are discussed.

Keywords

Distributed cognition, generative collectives, collective generative capacity, Q methodology, reflection, interaction, representation

INTRODUCTION

Cognition in collectives is a distributed, affect-laden phenomenon, in which individuals think and act in ways that take other people and their interdependencies into account, in order to enable shared learning and collective actions (Hutchins, 1990, 1991, 1995; Boland, Tenkasi, Te'eni, 1994). Hence, distributed cognition lies at the heart of Internet-based collectives and involves a process whereby individuals in generative collectives exchange their personal interpretations of a situation, reflect upon them, engage in dialogue about them and inform action with them (Boland et al., 1994). As such it provides the conditions for surfacing and challenging underlying assumptions, for complicating thinking, and for enabling generative acts of creativity, innovation, and change.

In this paper, we extend the notion of "generative collectives" (Van Osch and Avital, 2010) to describe groups of persons with shared interests or goals who mutually engage in rejuvenating, reconfiguring, reframing, and revolutionizing acts. Hence, the focus is on those sets of internet-based groups that engage in generative activities related to creativity, innovation and change. Generative collectives are of interest because they provide insights into a distinctive set of dimensions of collectivity that fosters grassroots creativity and innovation. We submit that any collective has the capacity to be generative to some degree; however, the manifested ability of a collective to engage in generative activities is likely to depend on the efficacy of a collective's processes of distributed cognition.

While most of the current literature regarding Internet-based collectives (e.g. online communities) consists of case studies (Johnson, 2001) thereby focusing on one community in particular without providing a holistic overview of important dimensions of online collectives for creativity and innovation in general, we aim to provide an in-depth exploration of the more general relation between distributed cognition and collective generative capacity through Q methodology. Within the Information Systems (IS) discipline, Q methodology has been considered a valuable method for providing an initial exploration and holistic explanation of phenomena, since it allows researchers to move beyond providing a mere assessment of whether a relation exists to an in-depth and holistic understanding of how and why this relationship exists (Thomas and Watson, 2002).

Based on distributed cognition theory, our findings show that three cognitive processes are fundamental to generative collectives, namely reflecting, interacting and representing (Boland et al., 1994) and that open, flexible structures and technology platforms result in an increase in these three processes. When these processes of reflection, interaction and representation occur, generative acts emerge from the actions of multiple individuals operating as a collective; that is, distributed cognition resides in the interrelations between the minds and activities of the individuals jointly constituting a collective (Weick and Roberts, 1993). Distributed cognition thus emerges from actions (Follett, 1924); hence, it is when actions of an individual begin to converge with actions of other individuals in the collective that distributed cognition is enacted.

In what follows, we first provide insights into the theoretical background underlying the notion of generative collectives and distributed cognition. Then, we describe Q methodology and outline the processes of data collection and analysis. Subsequently, we present the results of the Q factor analysis. Finally, we conclude with a discussion of the findings and implications for theory and practice.

THEORETICAL UNDERPINNINGS

Generative Collectives and Collective Generative Capacity

In this study, we draw on the notion of generative collectives (Van Osch and Avital, 2010; Van Osch, 2012), which refers to *groups of people with shared interests or goals that mutually engage in rejuvenating, reconfiguring, reframing and revolutionizing acts*. This conceptualization of generative collectives has its foundation in a large set of social science theories regarding collectivity and generativity as explored in detail by Van Osch (2012) (see Table 1).

Any type of collective has the capacity to be generative; however, some collectives are more generative than others. In order to understand why some collectives are more generative than others, we draw on the concept of collective generative capacity, which refers to *the ability to engage in acts of rejuvenating, reconfiguring, reframing and revolutionizing within a particular goal-driven context* (Van Osch, 2012). In this context, collective generative capacity should be understood as a trait. Like any trait, collective generative capacity can be absent or present, weak or strong, and thereby affects the actual generative acts and outcomes of a collective.

In this study, we analyze variations in the generative capacity of internet-based collectives through a distributed cognition lens.

Distributed Cognition

Distributed cognition was introduced by Hutchins (1990) in order to analyze and understand the cognitive processes that occur in a system of actors interacting with each other and an array of artifacts—representational media—to perform some sort of 'collective activity'. In order to understand how people in collectives mutually engage in generative acts, the distributed cognition provides a useful lens.

Distributed cognition is a process whereby individuals in a collective exchange their personal interpretations of a situation, reflect upon them, engage in dialogue about them and inform action with them (Boland et al., 1994). As such it provides the conditions for surfacing and challenging underlying assumptions, for complicating thinking, and for enabling change and other generative acts. Based on distributed cognition theory, three interdependent cognitive processes can be distinguished, which lie at the heart of generative acts, namely reflecting, interacting and representing (Boland et al., 1994) (see Table 1).

In the context of generative collectives, the cognitive process of *reflection* refers to the questioning and challenging of fundamental assumptions that form the basis for collective acts in order to uncover potential flaws. Collective reflection-in-action (Levina, 2005; Schön, 1983) determines how individuals in practice address uncertain and non-routine, yet, repetitive, problems that the collective deals with. Given the centrality of critical thinking and transforming the status quo in generative acts, it is evident that the level of reflection is closely related to the level of collective generative capacity.

In the context of generative collectives, the cognitive process of *interaction* refers to the need for dialogue and conversation in the context of collective acts. Interaction assumes an interplay and exchange in which individuals and collectives influence each other. Dialogue and interaction help people in the collective to discuss, contrast, and negotiate assumptions, interpretations, and meanings as a basis for subsequent confrontation and transformation.

In the context of generative collectives, the cognitive process of *representation* plays two different roles. First, representations supports the processes of reflecting and interacting by providing (1) insights into the envisioned practice and goal, (2) a structure for activities, (3) information regarding the progress on the envisioned practice, and (4) shared understanding of the process (Okhuysen and Bechky, 2008; Bechky, 2003; Boland and Tenkasi, 1995). Furthermore,

representations support the externalization of the outcome of the generative process and therewith help to support knowledge transfer and future generative acts.

Concept:	Sub-concept:	Source:	Definition:
Generative Collective		Van Osch (2012)	A group of people with shared interests or goals who mutually engage in rejuvenating, reconfiguring, reframing and revolutionizing acts
Collective Generative Capacity		Van Osch (2012); Van Osch and Avital (2011)	The ability of a collective to produce new (i.e. rejuvenation) or alter existing configuration (i.e. reconfiguring), to reassert the way we see and understand the world (i.e. reframing), and to challenge and transform the status quo within a particular goal-driven context
	Rejuvenation	Van Osch (2012)	The ability to produce novel configurations (i.e. radical innovation)
	Reconfiguring	Van Osch (2012)	The ability to alter existing configurations (i.e. incremental innovation)
	Reframing	Van Osch (2012)	The ability to reassert and restate the way we see and understand the world (changing perceptions and viewpoints)
	Revolutionizing	Van Osch (2012)	The ability to challenge and transform the status quo (changing actions and behaviors)
Distributed Cognition		Hutchins (1990, 1991, 1995)	The cognitive processes that occur in a system of actors interacting with each other and an array of artifacts—representational media—to perform some sort of 'collective activity'.
	Reflection	Boland et al. (1994)	The questioning and challenging of fundamental assumptions that form the basis for collective acts in order to uncover potential flaws
	Interaction	Boland et al. (1994)	The need for meaningful dialogues and conversational negotiations in the context of collective acts
	Representation	Boland et al. (1994)	The use of representational media to envision goals, structure activities, track progress, create mutual understanding, and externalize outcomes of collective acts

Table 1 Main Constructs and Definitions

As aforementioned and as depicted in Figure 1, the three processes of reflecting, interacting, and representing are closely interrelated in the context of collective generative capacity leading to collective generative acts. Although the distributed cognition that enables generative acts requires that individuals engage in reflection and interaction, it is important to note that representations—i.e. material objects—enable such reflective and interactive practices (Levina, 2005; Schön, 1983). By enabling individuals to produce rich representations of their understanding, others can reflect upon those representations, engage in dialogue about them with others and use them to inform action (Boland et al., 1994).

Thus, in the context of generative collectives, the three processes of reflecting, interacting, and representing form an entirety that is highly interdependent. Reflecting, interacting, and representing form a distinct pattern external to any given individual and represent the processes through which collective generative capacity becomes manifest (Weick and Roberts, 1993).

Distributed Cognition and Collective Generative Capacity

Based on the above theoretical discussion, we can conclude that variations in these three processes of distributed cognition correspond to variations in collective generative capacity, hence that:

Proposition 1: Higher levels of distributed cognition result in higher levels of collective generative capacity

Proposition 1a: Higher levels of reflection result in higher levels of collective generative capacity

Proposition 1b: Higher levels of interaction result in higher levels of collective generative capacity

Proposition 1c: Higher levels of representation result in higher levels of collective generative capacity

Jointly, these propositions suggest that collectives with lower levels of distributed cognition—reflection, interaction, and representation—are less likely to engage in generative acts. In contrast, in collectives with higher levels of distributed cognition, it is easier to produce generative outcomes.

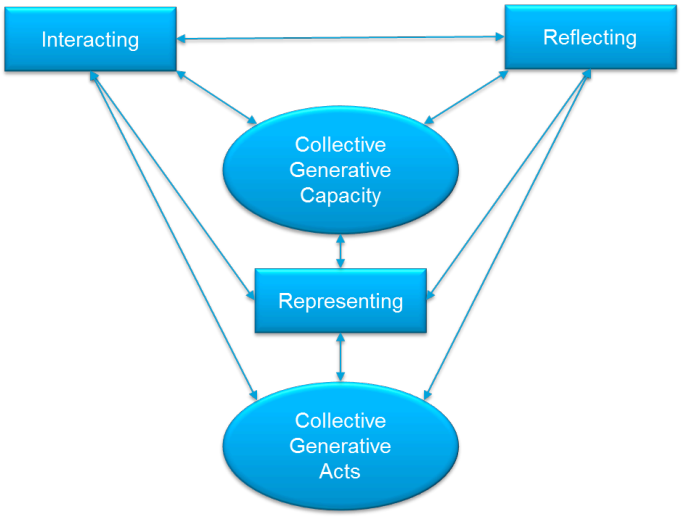
RESEARCH DESIGN

In order to explore the theoretical propositions outlined above, we used Q methodology.

Q methodology represents a systematic study of subjectivity (Brown, 1986) through a modified rank-ordering procedure in which stimuli—i.e. statements—are placed in an order that is significant and meaningful from the standpoint of the respondent (Brown, 1980: 195). According to Thomas and Watson (2002), Q-sorting offers several benefits to IS researchers; it:

- Provides a means for an in-depth study of small-sample populations
- Supports exploratory research
- Captures subjectivity in operation through a person's self-reference
- Does not require random selection of participants
- Protects respondent self-reference from researcher influence through the specific analysis techniques it uses

Figure 1: Three Cognitive Dimensions of Generative Collectives



Despite these advantages, there are some limitations to Q methodology, most importantly the limited generalizability due to small sample size. However, it is important to keep in mind that the use of Q methodology is primarily aimed at accessing diverse perceptions and therewith forms a good exploratory point of departure for the initial testing of theoretically founded propositions and for the developing of hypotheses for future quantitative research.

Q-sorting proceeds in three stages—research design, data collection and data analysis—each of which will be discussed below.

Concourse and Q Sample

The concourse—the sum of all things people say or think about the issue being investigated, i.e., collective generative capacity—for this study was collected from diverse expert sources including exploratory interviews, journal articles, websites, blogs, and magazines. Subsequently, a final selection of 40 statements that formed the final Q sample was drawn from the concourse of approximately 100 statements to ensure manageability of the sorting process for participations (Van Eeten, 1998). The selection process was aimed at obtaining an equal distribution across the various topics related to different dimensions of Internet-based collectives, including structure, processes and interactions, as well as technology platforms. Selection is further directed at reducing similarities, hence, maximizing diversity of statements (Brown, 1993; Thomas and Baas, 1992)[1].

Q-Participants

The Q-method requires a limited number of respondents (Webler, Danielson and Tuler, 2009; Swan, 2002). For a Q-sort with 40 statements, approximately 14 participants are needed (Webler et al., 2009), however, it is commonly advised to use somewhat larger samples. Hence, we invited 20 participants; a commonly used sample size for a study with 40 statements (Webler et al., 2009). These participants were selected because they represented a diverse range of backgrounds and areas of expertise in the realm of Internet-based communities—ranging from community managers, to platform designers, to social media marketers, bloggers, and researchers. Thus, the aim is not to estimate population statistics through random sampling, but rather to access the diversity of opinions regarding the subject matter.

Data Collection

During the Q-sorting interview, participants were presented with the Q-sample of 40 statements and asked to rank-order these statements from their individual point of view using a quasi-normal distribution (Brown, 1980). Hereto, they were asked to first divide the statements into three piles: 'agree', 'disagree' and 'neutral'. Subsequently, they were asked to take the 'agree'

[1] Although the selection of the Q sample is a subjective process undertaken by the researcher, it is the research subject that gives meaning to the statements by sorting them, hence, it is expected that factor convergence occurs (Brown, 1993; Thomas and Baas, 1992)

and 'disagree' pile and lay the cards on a response chart in the form of a quasi-normal distribution (see Appendix 1). Finally, participants were asked to fill the remaining spaces with the statements from the 'neutral' pile. During the sorting process, no outside source was allowed to guide the participant (Thomas and Watson, 2002), to ensure that participants' sorting is based on self-reference rather than external factors.

This self-referent response may be termed accurate from the participant' perspective as he or she has made the best choices possible within the options available (Thomas and Watson, 2002). Given that the forced quasi-normal distribution requires decisions, the interpretation of statements around the center of the distribution (-1, 0 and +1) may be intentionally neutral or leftovers with little value, therefore containing little to no information (Stephenson, 1974).

Upon completion of the sorting process, participants were interviewed regarding (1) the statements on both extreme ends of the distribution and (2) other statements they had strong opinions about. The aim of these interviews is to capture the participants' reasoning for their unique sorting, which is used for the later interpretation of the Q-factor analysis results.

Data Analysis

Q-factor analysis is the mathematical technique that is used to identify patterns among Q-sorts. Hence, the analysis produces social perspectives of the relations between the features of collectives and generative capacity compromising many people's subjective expressions (Webler et al., 2009). The application of factor analytic techniques focuses on preserving the participants' self-reference and comparative choice relationships so that patterns can be discovered from responses with *a priori* formulation (Stephenson, 1953).

In order to conduct the factor analysis, the software program PQMethod (Schmolck, 2011) was used. A principal components analysis was conducted, which considers both commonality among Q-sorts and specificity of individual sorts (Webler et al., 2009). Based on the results from the principal component analysis, five distinguishing factors were found. All five factors had eigenvalues larger than 1 and therefore were considered significant (Van Exel and De Graaf, 2005). However, following varimax rotation[2] with 3, 4, and 5 factors, three factors were selected for further analysis in order to maintain high parsimony. By using only these three factors for further analysis, rather than the initial five significant factors, high clarity, simplicity and stability of factors is ensured (Webler et al., 2009). Furthermore, correlations between these three factors were poor (see Bagozzi, Yi, and Philips, 1991) meaning these factors are highly distinctive (see Table 2).

Factor	Eigen-values	Corr. With Factor 1	Corr. With Factor 2	Corr. with Factor 3	Corr. With Factor 4	Corr. With Factor 5
1	9.8825	1.0000	0.5152	0.5923	0.3833	0.2593
2	1.6150	0.5152	1.0000	0.5329	0.3489	0.3395
3	1.3237	0.5923	0.5329	1.0000	0.3466	0.1939
4*	1.0621	0.3833	0.3489	0.3466	1.0000	0.2471
5*	1.0149	0.2593	0.3395	0.1939	0.2471	1.0000

* Not included for further analysis

Table 2 Eigenvalues and Correlations among Factors

These resultant factors represent groupings of people with similar patterns of response during the sorting—i.e. similar viewpoint. Hence, the loading of a particular respondent on a given factor indicates the level of (dis-)agreement (see Appendix 2) with this particular viewpoint and provide a basis for induction and abduction of observed effects in a given context (Stephenson, 1979; Brown, 1980).

RESULTS

As aforementioned, based on the principal component analysis, three distinguishing factors emerged as significant predictors of collective generative capacity. These factors will be explored and explained as follows.

[2] PQ method enables two rotation methods: varimax or theoretical (i.e. manual or judgmental) rotation. Varimax rotation is generally preferred because it is straightforward and transparent, hence, avoids researcher judgment or subjectivity in the analysis process (Van Exel and De Graaf, 2005). Rotation does not affect consistency in sentiment throughout individual Q sorts or the relationship between Q sorts, it only shift the perspective from which they are observed.

Factor 1: Collective Generative Capacity through Interaction and Reflection

Participants that load significantly on Factor 1 (see Table 3[3]) strongly believe that *interaction* and *reflection* with the aim of generating and sharing ideas represent the core processes of Internet-based collectives and are imperative to evoking and enhancing collective generative capacity. It is when people interact in Internet-based collectives that the sharing of ideas is enabled, out-of-the box thinking is instigated and consequently creativity and innovation are enhanced. Furthermore, Internet-based collectives provide people with a means to obtain information and share knowledge with everybody, including experts in specific domains. '*The strength [of Internet-based collectives] is the interaction with other people. Creativity is stimulated through out-of-the box thinking and the learning of ideas one would not think of themselves*.'

Additionally, participants loading on Factor 1 hold the opinion that online platforms represent the best means for spreading knowledge and sharing information. According to the participants, online platforms provide a fast and unbiased medium compared to other forms of media. '*Almost everybody has access to social media and can tell the world what they believe is worth spreading*'. Consequently, participants argue that Internet-based collectives and social media will be the best means for spreading knowledge in the future as these media are rapidly proliferating and gaining popularity. These media will be imperative to sharing knowledge, interacting, and reflecting, hence, they are key for future collective generative capacity. '*Social media is the way to share information in the future*!'

In short, then, participants who strongly agree with Factor 1 hold that Internet-based collectives are important places for *interactions* and *reflections* to occur between people and that, by bringing people together in dialogues and negotiations, these collectives provide an important foundation for collective generative capacity to emerge and evolve.

Statements	**Factor 1**	
	value	score
15. Interactions with diverse people in social media helps you to think out-of-the-box	4	1.83
2. Social media and online communities are the best way to spread knowledge for the future	2	1.15*
24. In social media, users should be able to do what they think a site or service is for, and not necessarily what it's designers intended.	2	1.05
18. If a system is fixed and cannot be changed or adapted by the users, people simply won't use it much.	1	0.72*
16. The majority of successful online communities to date tend to use technologies that cannot be adapted by the user	0	0.09
31. Online communities and social media should try to empower as many users as possible to actively contribute	0	-0.32*
11. Online interaction with hundreds of users does not promotes creativity and innovation more than online interaction with a few people	-1	-0.40
3. Communities that are extremely popular for a short period of time and then disappear are more innovative	-1	-0.65*
13. In an online community, people are more likely to share and enforce their own opinions and ideas than to learn from other people's opinions and ideas	-2	-1.30*
37. Social media is not about stimulating future learning through knowledge sharing	-3	-1.31

* Indicates Significance at P < .01)

Table 4. Distinguishing Statements for Factor 1 P < .05

Factor 2: Collective Generative Capacity through Representation

Participants that load significantly on Factor 2 (see Table 4) primarily emphasize the importance of *representation*, that is, of documenting and subsequently exchanging ideas and knowledge. Evidently, participants continue to emphasize the importance of interaction in this respect. '*In your work it is important to interact with people from the same work field. Online one can get into contact with experts easily, share ideas, read what others wrote, gain new information and get more ideas yourself*.' In this context, participants argue that the documenting—i.e. representing—of generative acts enables other people to expand on and improve previous work rather than reinventing the wheel. '*It would be weird and a waste not to document innovation*.'

[3] Value (column 2) refers to the unstandardized weighted average statement score of respondents that define that factor. Score (column 3) refers to the normalized weighted average statement score (Z-score) of respondents that define that factor.

Furthermore, participants emphasize that representations inspire, hence, trigger new cycles of idea generation and innovation. *'Innovation comes into being when you see what others are doing.'* Additionally, representing ideas also triggers new cycles of reflection: '*When you're writing your ideas down, you force yourself to rethink these ideas and create the possibility for others to criticize your ideas*.' Hence, it is important to document ideas in a clear and obvious fashion. '*You have to document your ideas well, because what is the use when it is abstract and vague? When people don't understand ideas they cannot criticize and improve them'*.

In short, then, participants who strongly agree with Factor 2 submit that representations are indispensable means for spreading and documenting knowledge, for triggering subsequent interactions and reflection and therewith for evoking and encouraging collective generative capacity.

Statements	**Factor 2**	
	value	score
15. Interactions with diverse people in social media helps you to think out-of-the-box	3	1.29
5. Written and visual documentation of innovations leads to more innovation	3	1.24*
26. A successful and innovative community needs enforceable guidelines or rules for all participants to follow.	1	0.51*
32. Having long-term (stable) members is better for innovation and creativity in online communities	1	0.50
39. The success of online communities depends on the amount of interaction and mutual engagement.	1	0.44*
30. The most innovative community is a managed community; which is carefully controlled by core members	1	0.41*
38. Social media should give users the ability to update and change tools quickly when new circumstances arise	0	0.06
28. Designers should be completely able to control what users can do with support tools in online communities	-1	-0.06*
24. In social media, users should be able to do what they think a site or service is for, and not necessarily what it's designers intended.	-1	-0.57*
29. Abstract and vague documentation of innovations leads to more innovation	-3	-1.66
12. Online communities should not document innovation so it can be re-interpreted in the future	-4	-1.79*
3. Communities that are extremely popular for a short period of time and then disappear are more innovative	-4	-2.20*

* Indicates Significance at P < .01)

Table 4. Distinguishing Statements for Factor 2 P < .05

8.2.3 Factor 3: Collective Generative Capacity through Lack of Structure

Participants that load significantly on Factor 3 (see Table 5) focus on elements of *structure* in their individual reflections. They believe that within an online collective, hierarchical organization and coordination is not a prerequisite for evoking and enhancing innovation. Rather, they argue that too much hierarchy and structure acts as an impediment to creative thinking. Participants propose that a more chaotic model, as characterized by the lack of strict rules and procedures, helps people to think out of the box and become more creative and innovative. '*I'm an advocate of as little hierarchy as possible, lots of freedom and happiness, let things happen by chance*.'

The importance of fluid structures becomes further apparent from participants' emphasis on the negative effect of rules and procedures on collective generative capacity, they do indirectly express the belief that more stable collectives—characterized by clear rules and procedures—likely diminish collective generative capacity. '*You should create a framework in which members are flexible and can interact freely, and then people become creative and innovative*.'

Furthermore, a latent theme in these reflective interviews is that also the *technology platforms* employed by an Internet-based collective should support freedom. Participants argue that users should be able to do what they think a site or platform is for, rather than what the designer or others think it is for. Participants argue that if the design of an online platform hinders people, they become less open and less creative. '*Innovation occurs when people go astray*.'

In short, then, participants that strongly agree with Factor 3 believe that hierarchy, strong rules, and procedures overall negatively affect collective generative capacity and that for collectives to be generative, free and open structures are essential. Similarly, open technologies are perceived to further enable and enhance collective generative capacity.

Statements	Factor 3	
	value	score
1. Social media and online communities can support innovation without the need for complex hierarchical organization	4	1.98*
24. In social media, users should be able to do what they think a site or service is for, and not necessarily what it's designers intended.	3	1.79
36. An informal style of communication and interaction without strict rules and procedures leads to a successful and innovative community	3	1.41*
15. Interactions with diverse people in social media helps you to think out-of-the-box	1	0.53
3. Communities that are extremely popular for a short period of time and then disappear are more innovative	1	0.43*
35. Online interaction helps people to challenge and transform popular assumptions	1	0.38*
33. Online interaction is valuable for becoming aware of one's own ideas and for learning new ideas	0	0.16*
6. The diverse nature of online interactions affect one's ability to learn from the perspectives of others.	0	0.14
25. An established and stable social community is a prerequisite for innovation and action.	-2	-1.19

* Indicates Significance at P < .01)

Table 5. Distinguishing Statements for Factor 3 P < .05

DISCUSSION AND CONCLUSION

In what follows, the core findings of this Q-sorting study will be briefly summarized by relating the results to the theoretical insights regarding generative collectives and distributed cognition that underpinned this study. Based on these insights, a set of implications for research and practice are discussed.

The first set of findings shows that there is general consensus among the participants that cognitive processes lie at the heart of generative collectives, hence, are indispensable for enhancing generative capacity. Although both Factor 1 and Factor 2 emphasize the importance of cognition in relation to collective generative capacity, each factor focuses on a different aspect of cognition. Factor 1 emphasizes primarily the cognitive processes of interaction and reflection, that is, the *generating* and *sharing* of ideas through dialogues and negotiations with others. Factor 2, on the other hand, emphasizes primarily the cognitive process of representation, that is, the *documenting* and *exchanging* of outcomes of the generative process for future use and reference by others. Therefore, the propositions regarding the relation between cognition and collective generative capacity can be accepted, that is, higher levels of interaction, reflection and representation result in higher levels of collective generative capacity.

This empirical model of distributed cognition that emerged from the Q-factor analysis findings strongly resembles the duality of knowledge described by Wenger (1998). In considering everyday practices of negotiating meaning in Communities of Practice (CoP), Wenger (1998) argues that these practices encompass two constituent processes, participation and reification, which jointly form a duality. *Participation* is a process in which people are active participants of a community engaging in activities with a selected group of people. Participation involves all kinds of relations, both harmonious and conflictual, for acting together as well as for developing identities. Participation is thus closely related to the processes of reflecting and interacting that are core to distributed cognition in the context of generative collectives.

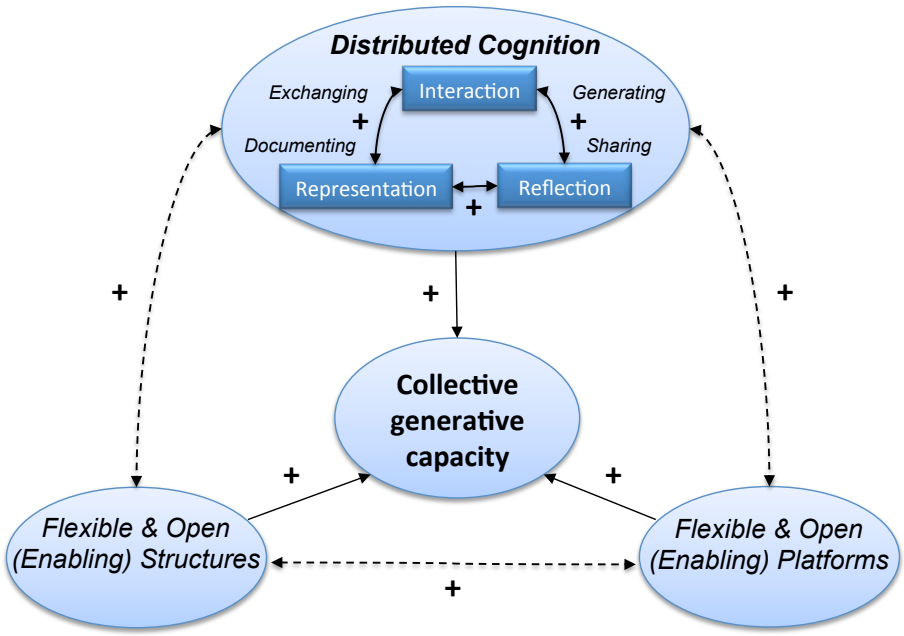
Yet, according to Wenger (1998: 55-59), participation remains undefined without the other constituent process, *reification*, which refers to giving concrete form to something that is abstract. Hence, reification is about representing, that is, about producing material objects that congeal our experience and meanings for others and thereby attain an independent existence. It is important to understand that if either one of these processes dominates; there is little opportunity for shared action and practices. If participation prevails, then there may not be enough materiality for coordination and for uncovering diverging assumptions (Wenger, 1998; Levina, 2005). If however reification prevails, there may not be enough interaction to create shared experiences and meanings nor reflective negotiations to inform collective action.

The second set of findings, based on Factor 3, emphasizes primarily the importance of structure in relation to collective generative capacity, and more specifically, the importance of fluid structure—i.e. the lack of rules and procedures—in order to allow creativity and innovation to flourish. Furthermore, Factor 3 revealed that the general opinion among participants is that the technology platforms of Internet-based collectives—like their structure—should be designed in such a way that it

allows maximum freedom in use in order to enable interaction, reflection, and collective generative capacity. '*You have to design technology in a way that you can do whatever you want*.'

In sum, it thus appears that the cognitive processes of interaction, reflection, and representation represent the core of generative acts in Internet-based collectives. In other words, these processes are most significant for influencing the degrees of freedom and inherent agility of a collective that subsequently results in high generative capacity. Additionally, the structure and technology—when designed in such a way that they are flexible and open, rather than restrictive—represent the supportive context and tools for enabling and encouraging people to interact, represent and reflect freely in the course of being generative. Based on these insights, we propose the following process model of collective generative capacity (Figure 2). As Figure 2 suggests, fluid structures and open technologies have a positive effect on distributed cognition, which in turn positively influences the generative capacity of Internet-based collectives.

Figure 2: Process Model of Collective Generative Capacity



Based on the above findings, this study provides two important contributions. First, by conceptualizing generative collectives, a more general framework for analyzing, understanding, and classifying Internet-based group activities of all sorts occurring in a wide range of collectives is provided. Second, by untangling and explaining the relationships that exists between distributed cognition and collective generative capacity, our findings show that enhancing generative capacity requires distributed cognition, which in turn, can be supported and encouraged by a properly designed structure and technology. These insights are relevant for informing future quantitative studies of Internet-based generative collectives and distributed cognition as well as for designing systems and environments that are conducive to distributed cognition and therewith enhance collective generative capacity.

To conclude, generative collectives evolve around people; hence, it is the people and the interactions among them that make some collectives more generative than others. Interaction, reflection, and representation are the core cognitive processes that constitute generative acts within online collectives. Thus collective generative capacity emerges from the synergetic and dialectical combinations of individual minds through interaction, reflection, and representation.

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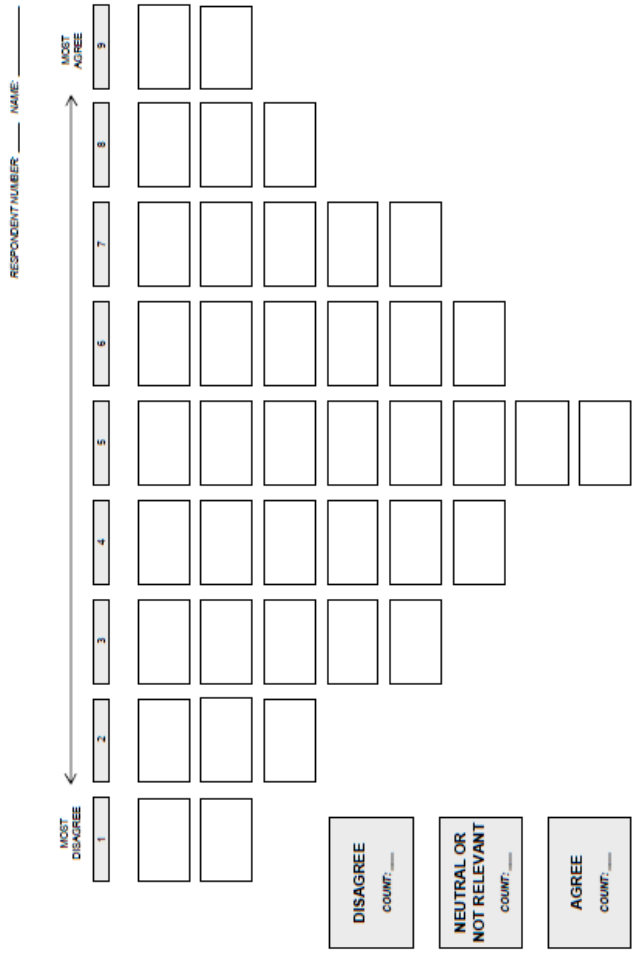
APPENDICES

Appendix 1: Response Chart



Appendix 2: Factor Matrix

Factor Matrix with an X Indicating a Defining Sort

	Loadings		
QSORT	1	2	3
1	0.1698	0.7382X	0.0020
2	0.0514	0.6426X	0.5278
3	0.5539X	0.1402	0.3972
4	0.8671X	0.1844	0.1681
5	0.6188X	0.1634	0.4097
6	0.4506	0.2724	0.4414
7	0.5313	0.7031X	0.2264
8	0.1663	0.4761X	0.1206
9	0.1416	0.1092	0.8123X
10	0.3949	0.2793	0.6668X
11	0.8495X	0.2945	0.1726
12	0.5573	0.2861	0.5534
13	0.5833	0.5259	0.2982
14	0.2142	0.5234X	-0.0170
15	0.3023	0.2134	0.7502X
16	0.5974X	0.3801	0.4450
17	-0.0243	0.6943X	0.4669
18	0.4507	-0.0014	0.6753X
19	0.6784X	0.5413	0.2537
20	0.3173	0.6471X	0.2825
% expl.Var.:	24	20	20