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RESEARCH ARTICLE

What is shared? A framework for understanding shared innovation within communities

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Abstract The twenty-first century economy often requires the innovative production of conceptual and physical artifacts. These innovations frequently are developed collaboratively within communities of workers. Previous theories about the nature of work and learning within communities have emphasized shared meaning or shared practice, but now shared innovation is required. In this paper, I describe the development of a model for conceptualizing and studying shared innovation within communities. This model was created from merging elements of social learning and creativity/innovation theories. I explain that at an intersection of these two domains is a unique kind of social structure, called a Community of Innovation, or COI. I conclude by describing the characteristics of a COI and its implications for design and research.

Keywords Communities of practice · Innovation · Creativity · Communities · Collaboration · Social learning theory · Communities of innovation · Information age · Innovation economy · Social learning

According to Feather (2003) the Information Age entails real economical, technological, sociological, and historical changes. These changes have enabled ubiquitous access to information (through the Internet, public databases, digital media, etc.) and ubiquitous communication, or access to social networks (through emerging social technologies and mobile devices). These two trends combine to create a very different society from previous generations—one that necessitates a different understanding of how people learn and work as communities. Ubiquitous communication has stimulated collaboration and community-based development of new ideas, technologies, and practices, while ubiquitous information

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in capitalistic societies has required many companies to prize the creation of new knowledge and artifacts (Proctor 2005). Simply knowing how things have been done is no longer sufficient as creative output is valued, and often required, through collaborations among workers. Researchers and practitioners have called these skills the "essential competence" (Hakkarainen et al. 2004, p. 139), the "critical pre-requisite" (Coakes and Smith 2007, p. 74), and the "ultimate economic resource" (Florida 2002, p. xiii).

Because of the characteristics of the Information Age (ubiquitous access to information and social networks), a new innovation economy has developed (Banahan and Playfoot 2004; Coakes and Smith 2007). It is disappointing, however, that despite these societal trends, educational systems have largely remained models of the Industrial Age (Reigeluth 1994). Likewise, researchers have largely not been as attentive to the needs of learners and workers in an innovation economy. In this paper, I begin a discussion to fill this void by presenting a framework (communities of innovation, or COI) for understanding the communal, collaborative nature of innovation. I first explore ideas from two different academic disciplines that can inform our understanding of COIs. From social learning research I discuss theories on the meaning of "shared" learning and what exactly is shared and co-constructed among learners. From creativity research, I report a steady progression from individual perspectives to considering the group nature of creativity. I will then present my concept of COI and conclude by offering implications for research and design.

Development of social learning theories

Social learning theories are key to understanding COI because they help us understand the nature of collaborative work and learning, and collaboration is a key element of innovation. Also, social learning theories provide insight into the impact that technology has on how we socialize as students or colleagues. Social learning theorists, as a group, have sought to understand what is shared in social learning, with a progression from concepts of shared meaning, to shared practice, to shared innovation.

Shared meaning

Early social learning theorists explored how interaction between an individual, others, and the environment constructed shared knowledge understood among all of the participating members. Much of our understanding of shared meaning is traced to the Soviet psychologist, Vygotsky (1978, 1986, 1987, 1997). According to Vygotsky, before any concept or understanding is formed internally it exists external to the individual, and is thus social in its nature. "Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane" (1981, pp. 162–163). As an example, Vygotsky described how an infant learns to communicate via gestures. The child makes a hand motion, but does not initially understand it to be a communicative gesture until the parent reacts and communicates love back to the child (Wertsch 1985). This concept of shared meaning is the basis for Vygotsky's theory of the "zone of proximal development" (ZPD), or an area of development that could be facilitated through interaction with and scaffolding from the environment. Thus, with the ZPD, student learning becomes a negotiated process between the student and the environment to jointly arrive at an understanding that is afterwards internalized by the learner.

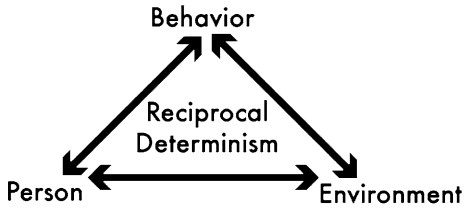

Fig. 1 A model of reciprocal determinism, reproduced from Bandura (1986)

Bandura (1977, 1986) broadened these ideas of social interaction and suggested that behavior and learning occurred as the result of continual interactions among the person, the environment, and the behavior: "Many factors are often needed to create a given effect. Because of the multiplicity of interacting influences, the same factor can be a part of different blends of conditions that have different effects" (Bandura 1986, p. 24). The interaction between causal factors depicted in Fig. 1 occurs continually, constantly renegotiating understandings and changing behaviors.

Bandura's social learning theory opened new avenues for examining the effect of environmental/individual interactions on student learning, such as student motivation, self-efficacy, self-regulation, and other factors now seen as critical to successful learning. These concepts are also important to understanding shared innovation, which often depends on persons being intrinsically motivated and self-regulated, as I will discuss later. In addition, group innovation occurs from the juxtaposition of diverse perspectives with the group's shared understandings. In this way, the ideas of theorists like Vygotsky and Bandura are an essential first step to understanding COI.

Shared practice

By developing theories of shared social practice—examples include situated cognition and communities of practice (COP)—researchers furthered our understanding of how community members interact and bring new ideas into the group. This trajectory for new ideas and perspectives laid a foundation for understanding innovation within communities, but without addressing innovation directly. Brown et al. (1989) presented a "fragment" of the theory of situated cognition by explaining that knowledge is inescapably tied to the context and practice in which it was used. Thus, the same word could have very different meanings depending on the context ("ball" could mean something hard or soft, depending on the context). Building from this conception of knowledge, Brown et al. (1989) argued that learning requires a student "like an apprentice, [to] enter that community and its culture" (p. 33). For effective learning, students must engage in authentic activities of that culture, even if only in minor or peripheral ways (Collins et al. 1989; Lave and Wenger 1991) so they can "steal" tacit knowledge from experts through observation of their practices (Brown et al. 1993; Brown and Duguid 2002).

Brown et al. (1989) based many of their ideas on the work of Lave, who with Wenger developed theories about learning and working within COP (Lave and Wenger 1991). Wenger (1998) argued that social participation is the critical requirement for learning. According to Wenger, social participation comprises four components: meaning, or learning as experience; practice, or learning as doing; community, or learning as belonging; and identity, or learning as becoming. Thus, learning involves much more than knowledge acquisition because it engages the whole person in a co-constructive, interactive process oriented towards developing the expertise of people as they integrate into a

professional community. In essence, the theory effectively shows how people learn to be efficient and gain tacit, procedural knowledge while working towards becoming experts. In Wenger's words, knowledge within a COP is defined as competence in an endeavor in which one is actively engaged with others (1998, p. 4). While the theory accommodates new ideas as part of the integration of new people into a community, the core of the theory is focused on gaining competence and developing meaning, rather than on creating innovations.

The historical development of creativity research

While social learning theories have explained how members of a community develop shared meanings, cultural practices, and expertise, a theory is still needed to explain how communities act and function when their primary purpose is not competence or knowledge, but innovation. Research into human creativity helps to develop this innovative aspect of a community of innovation model. To examine potential links between creativity theories and social learning theories, I will provide a brief overview of the history of creativity research from its early roots to the present discussion on group innovation. Throughout this section of the paper, I mostly employ the term "creativity" because this is the wording used by this group of researchers (Csikszentmihályi 1990a). Creativity researchers use the term to describe "the creation of an *original* and *useful* product" (Mayer 1999, p. 449), but their work often emphasizes the idea generation and selection stages of creativity—what is called divergent and convergent thinking. In all other sections of this paper I use the term "innovation" because I believe it is more expansive. Innovation theories include not only initial divergent/convergent thinking processes, but also idea development, the overall innovation climate within the community, and factors related to implementation (Amabile et al. 1996; West 2003).

Big creativity

The roots of creativity theories grew from philosophical/mystical origins, as philosophers argued about the nature of divine intervention and of insight pouring forth into a person's mind from some outside source (Albert and Runco 1999; Sternberg and Lubart 1999). For example, according to Plato, creativity and genius could not be developed or explained, as they came from God unexpectedly: "This gift you have of speaking well…is not an art, it is a power divine, impelling you…therefore each is able to do well only that to which the Muse has impelled him" (Rothenberg and Hausman 1976, pp. 31–32). Like Plato, Kant suggested that schooling could not produce creativity, and that creativity could not be harnessed or controlled. "[A genius] does not know himself how he has come by his Ideas, and he has not the power to devise the like at pleasure or in accordance with a plan" (Rothenberg and Hausman 1976, p. 38).

Eventually, researchers began investigating the individual differences between creative people and less creative people (Albert and Runco 1999). One prominent way to identify creative attributes was to focus on "Big C" creativity (Snyder and Lopez 2002), or the study of people who displayed obvious flashes of brilliant insight. Thus, early (and some current) creativity researchers focused on the study of geniuses through biographies and historiometric methods (Albert and Runco 1999; Mayer 1999; Simonton 1999). During the early twentieth century, researchers pushed creativity research toward a study of human

intelligence, linking high intellectual ability in children with eventual creative achievement as adults (Albert and Runco 1999). This research emphasized the importance of the truly gifted, but also hypothesized about its developmental nature. Researchers began to question whether creativity could possibly be taught and developed, and thus exist in differing degrees among normal, everyday, people.

Everyday creativity

The study of creativity was neither popular nor well respected until Guilford's (1950) famous presidential speech to the American Psychological Association. Guilford reported that only 0.2% of published psychological articles in *Psychology Abstracts* had discussed creativity, and he argued for rigorous experimental research into the topic. Researchers developed psychometric scales, tasks, and experiments for objectively measuring potential creativity and found associations between different personality traits, decision-making processes, cognitive processes, and the "everyday" or "little c" creativity of people (Sternberg 1999).

As a result, substantial research identified the cognitive activities underlying creativity. These findings demystified creativity and provided increased power in predicting interventions that influence creativity (Smith et al. 1995). Ward et al. (1999) wrote that creativity is simply an extension of normal cognitive processes available to everyone. Weisberg (1999) characterized creativity as incremental progress based upon prior knowledge. This view was shared by Ward et al. (1999), who suggested that novel ideas involve a restructuring of new information with old knowledge to create new mental representations (Smith 2003). While some have argued against the pure cognitive approach to creativity (e.g., Bowers et al. 1995), the end result of this theoretical movement was an appreciation of creativity as something that all could develop to different degrees.

Social/group innovation

Whether researchers have studied rare genius or everyday creative personalities and processes, a common thread has been the primary focus on individuals. Even when researchers referred to environmental and societal conditions, they did so to show how they influenced individual creativity. In summarizing the leading research topics in the *Handbook of Creativity*, Mayer (1999) listed 12 questions, only one of which might be interpreted to reflect the social nature of creativity. Henry (2004) wrote that "until recently much of Western psychological thinking about creativity has assumed that creativity is a quality that emanates from an individual, and most creativity research has been framed in line with this assumption" (p. 158).

Recently, some researchers have written that there is an alternative view to creativity that emphasizes its group or social nature. Montuori and Purser (1999b) said that "many creative activities today involve social and collaborative processes" and yet "considerably less [research] has looked at how social factors can promote creativity for all" (pp. 4–5). Paulus et al. (1999) concluded, "very little attention and recognition is given to the potential for group creativity" (p. 152). They noted that a computer survey of social science literature since 1989 yielded no citations for "group creativity." Even one of the most well known creativity theorists wrote that he has "reluctantly" come to realize that creativity must be studied as an event as much social and systemic as psychological (Csikszentmihályi 1990a).

Why has creativity research focused so heavily on individual factors? Some researchers believed it was because of the influence of cognitive psychology perspectives (Mandler 1995). Paulus et al. (1999) wrote, "this localization of creativity within the individual is consistent with a variety of cognitive or attributional biases that lead us to ignore the social or environmental context of creativity" (p. 151). Another reason for the lack of social creativity research could be the dominance of the Western World in creativity research, and the Western focus on the individual. "Countries like Japan have an excellent record of continuous improvement in their products and processes, perhaps because they recognize that creativity is very much about collaboration over time and not just breakthroughs by a few individuals" (Henry 2004, p. 170).

Near the end of the twentieth century, a social/group creativity research movement gained strength (Montuori and Purser 1999a; Paulus and Nijstad 2003; Purser and Montuori 1999). However, this research often focuses only on group divergent thinking and group convergent thinking. Divergent thinking is the ability to deviate from the normal to consider novel possibilities. It is frequently used to identify an individual's creative potential (Runco 1991) by posing a problem (or object) and asking for as many solutions (or uses) as possible.

Researchers have studied group divergent thinking by looking at the brainstorming process. They have found that group divergent thinking is often hindered by groupthink, which occurs when a dominant person offers an idea that is prematurely accepted by the group (Milliken et al. 2003; Nemeth and Nemeth-Brown 2003; Smith 2003). Seeking a balance in skills, backgrounds, and expertise within the group can help groups avoid groupthink and improve group divergent thinking. However, the benefit derived from group diversity might not surface if members do not feel comfortable in expressing their dissenting opinions (Nemeth and Nemeth-Brown 2003). These findings support the need for a strong community where members feel valued, confident, and interdependent with each other, a feature of the community's climate that I discuss below. Emphasizing this interdependence and strength in diversity can improve group divergent thinking processes.

During the divergent phase of an innovative project, the group generates as many novel ideas as possible. When the activity shifts towards collaborative convergent thinking, the group must winnow the ideas down to only the best. While some researchers characterize convergent thinking negatively (see, for example, Goncalo 2004; Nemeth 1986), others advocate a mix of positive divergent and convergent thinking within groups to foster creativity (Kaner and Karni 2007). Larey (1995) found that interacting groups were more successful on convergent thinking tasks than they were on divergent thinking tasks. This result may indicate a need for increased interactivity during this part of the group innovation process. Diversity among membership is also important in convergent thinking, leading to superior ideas (Milliken et al. 2003) and improved decisions due to an increased number of possible critical evaluations. In convergent thinking, independent judgment is important in keeping the group from attaining consensus before fully evaluating all ideas, a process called "premature closure" (Kim 2007). Because of this, full participation by all of the group's members is critical (De Dreu and West 2001). To be successfully innovative, the group must function as one unified whole.

In addition to research on group convergent and divergent thinking, a few researchers have studied overall organizational climate conducive to innovation. Amabile et al. (1996), for example, presented a model for how an organization influences its members' creativity. This model (and subsequent measurement instrument) included five components: Encouragement of creativity, autonomy/freedom, resources, pressures (both positive and negative influences on creativity), and organizational impediments. A similar measurement

device used to assess team climate for innovation is the Team Climate Inventory (Anderson and West 1996). This instrument assesses participative safety (how much team members participate and feel safe with each other), support for innovation, vision, and task orientation. This work provides a good foundation for discussing how organizational variables influence innovation, but many questions remain about how innovation emerges within these social communities.

Shared innovation: the communities of innovation model

From this research on group creativity, we can identify a few key principles for the formation of a community of innovation. These include: diversity, interdependence and full participation among group members; idea generation and selection; and a supportive climate for innovation. By combining these principles with the rich theoretical foundation available in social learning research, we can derive a model to explain how innovative communities might function and be fostered. Some theorists have already sought to describe the nature of a community focused on the creation of physical or conceptual artifacts. They have used various names to describe these communities, including wisdom networks (Benton and Giovagnoli 2006), knowledge creating communities (Bielaczyc and Collins 2006), creative organizations (Banahan and Playfoot 2004), communities of creation (Sawhney and Prandelli 2000), networked strategic communities of business (Kodama 2005), and innovative knowledge communities (Hakkarainen et al. 2004). Coakes and Smith (2007) used the term "communities of innovation" to describe a community developed around a specific "innovation champion," although their work focused on the individual champion rather than the community.

In my model, I also use the name *communities of innovation* to reflect the innovative nature of the community. In addition, while creativity has typically been associated with idea generation, the term *innovation* expands to include idea development and implementation (West 2003). Finally, in the model I am presenting, I focus more on the development of the whole community, rather than an individual within the community (Coakes and Smith 2007). Whatever these communities are called, there are elements that these models have in common that can provide a basis for understanding what a community of innovation (COI) is. The following COI framework is based on elements derived from these different bodies of research: Social elements from social learning theories, creativity elements from creativity literature, and organizational elements from the emerging discussion about innovative organizations.

Elements of a community of innovation

Dynamic expertise or group flow

Whereas expertise is often viewed as a finish line, where one has enough experience, knowledge, and wisdom to be viewed by his/her community as an expert, Hakkarainen et al. (2004) argued that innovative communities require dynamic expertise. This expertise is "characterized by continuous efforts to surpass one's earlier achievements and work at the edge of one's competence" (p. 243). This orientation allows the learner to take on new roles within the community: sometimes as the expert, sometimes as the novice, but always growing in expertise. Csikszentmihályi (1990b) incorporated aspects of dynamic expertise

into his flow theory of learning, where he argued that learning is best accomplished by learners continually pushing themselves to complete intrinsically interesting projects that are just beyond their level of expertise. This kind of activity requires intense focus, learning, and development, but results in discovery and creation, among other outcomes (Csikszentmihályi 1990b).

Keith Sawyer adapted Csikszentmihályi's concept of individual flow to explain a specific kind of optimal group flow (Sawyer 2008). Drawing on his research with groups as diverse as sports teams, jazz combos, and business organizations, Sawyer (2008) found 10 key conditions enabling group flow: (1) a shared goal, (2) close or deep listening to each other, (3) complete concentration, (4) being in control of the group's actions and environment, (5) blending of individual egos, (6) equal participation, (7) members' familiarity with each other, (8) constant communication, (9) elaboration of each others' ideas, and (10) frequent failure (and learning from failure). By developing and encouraging dynamic expertise, fluid role-sharing within the group, and the kind of synchrony leading to group flow, groups can most effectively become innovative.

Entrepreneurship & ownership

Entrepreneurship is critically linked to innovation (Coakes and Smith 2007; McFadzean et al. 2005). Laat and Broer (2004) identified three types of organizations: machine organizations, with a central bureaucracy and formalized procedures; professional organizations that are bureaucratic but with decentralized power; and entrepreneurial organizations. Entrepreneurial organizations are "simple, informal, and flexible organization[s]" (Laat and Broer 2004, p. 61). Members of this type of community share intuitive knowledge through "intense" networking both inside and outside the immediate organization.

Entrepreneurial networking allows members of the community to retrieve organizational knowledge from other experts, re-use and repurpose the information, and create new knowledge that is then shared with the network. Banahan and Playfoot (2004), in describing learning within the "creative economy," explained that individuals will no longer be able to expect stability within work establishments as organizations grow to exist more virtually. They noted that individuals need to become increasingly entrepreneurial and that adaptability and reactivity are critical elements of professional learning. McFadzean et al. (2005) added that "without the presence of some form of entrepreneurial activity to exploit opportunities as they arise within organisations, innovation remains little more than an aspirational, rather than a tangible destination" (p. 353).

Workers must now learn how to change roles frequently and be multi-skilled instead of dependent on a trade. Thus apprenticeship models popular in situated cognition theories are not as applicable to COI as models that reflect adaptability and flexibility. Innovative communities need to develop the unique type of environment that allows enough structure to keep the community together and focused on an end goal, but enough flexibility to allow individual members to take ownership over their own projects and ideas.

Inquiry

Engestrom (1999) identified inquiry, or questioning, as a critical element of his model for expansive learning cycles, which are related to COI. Engestrom reported that to be innovative learners, people must first raise questions, analyze the situation, model a new explanation, examine and implement the model, reflect on the process, and consolidate the new practice. For Engestrom, this act of questioning includes "criticizing or rejecting some

aspects of the accepted practice and existing wisdom" (p. 383), and is the first step in transforming abstract ideas into complex objects in activity systems.

Hakkarainen et al. (2004), in their knowledge-creating communities model, believed it was essential for members to generate their own problems and questions to guide their activities. "All models of innovative knowledge communities," they argued, "….highlight the role of problems and questions that guide the process of knowledge creation" (p. 197). To be most useful, community members should generate these questions themselves. However, despite the focus by these and other researchers on inquiry-based learning, inquiry and argumentation rarely occur in modern schools (Kuhn 2005), leaving many people ill prepared to be curious and questioning. In the Innovation Age, the focus on group inquiry will become increasingly critical as problem-finding, or seeking and defining questions to be solved, is a key precursor to innovation.

Group reflectiveness

Reflection, the final stage of Engestrom's learning model, is a component of most innovative learning community models. Bielaczyc and Collins (2006) argued that "The pulling together of disparate elements through reflection is crucial to knowledge creation.…[and] can support process and product refinement over time" (p. 44). Hakkarainen et al. (2004) explain that two kinds of reflection are important: intrapersonal reflection and interpersonal reflection. "All models of innovative knowledge communities highlight the importance of self-reflection and reflection within a community. New knowledge often emerges as a consequence of these kinds of practices of reflection-in-action" (p. 133). Sawyer (2008) included this concept of group reflectiveness, or learning from past group failures, as the final key in his theory of group flow. For any community to be truly innovative, it must foster this communal, group introspection and reflection in an arena of psychological safety (Rogers 1954) so that it can improve its own innovative processes.

Innoversity

In traditional COP, diversity is a valuable way to bring in new knowledge from outside the community, and COP members reflect a diverse range of people brought together by mutual engagement in the shared practice. Diversity in skills or competencies, however, is not always critical for a successful COP, according to Wenger (1998), who described communities as sometimes consisting of *complementary competencies* and sometimes of *overlapping competencies*. In a case study of the latter, Wenger described claims processors who were a group of people diverse in backgrounds, opinions, and cultures, but who shared the same competency and work: They were all claims processors.

In COI, diversity plays a much more essential role because what is shared among the community is not competency or work, but the creation of something new. Justesen (2004) coined the term "innoversity" to describe how innovation is interlinked with diversity in a community. She defines diversity not in racial or cultural terms, but as variety in "techne (skills and abilities) and cognition" that allows for "new knowledge from previously separated domains [to be] exchanged and combined in new ways" (pp. 80–81). Bielaczyc and Collins (2006) echoed diversity, or "multiple perspectives" as one of the seven characteristics of knowledge-creating communities. They argued that innovative learning communities require these multiple perspectives because "They raise questions about what is the best approach. They provide different possible solutions. . . . They offer ingredients for new syntheses.…[and are] critical to the invention process" (p. 42). Thus it is common

for COI, like the industrial design firm IDEO, to engage psychologists, evaluators, CEOs, designers, and many other kinds of professionals together to foster innovative thinking (Nussbaum 2004).

New community boundaries, visions, and goals

In the past, time/spatial boundaries have often characterized communities (Rovai 2002; Rovai et al. 2004), and learners who work, study, or associate frequently together either by mandate (they are in the same class or work team) or by choice comprised these groups. In COIs, time/spatial boundaries are blurred, and it is more likely that members will rely on personal networks that include community members within spatial reach as well as those that are physically distant (Sawhney and Prandelli 2000). In addition, the visions and goals of a COI are focused more on innovation than on efficiency. In discussing wisdom networks, their term for a COI, Benton and Giovagnoli (2006) argued that COIs cannot be harnessed or controlled by management, and should not have mandated deadlines, goals, or imposed leaders. This is because the purpose of these communities is not efficiency but innovation. As Sawhney and Prandelli (2000) argued, these communities must have "a permeable system, with ever-changing boundaries. [These communities lie] between the closed hierarchical model of innovation and the open market-based model" (p. 25). Innovation communities must have emergent goals, visions, and ever-changing boundaries as they accommodate the influx of diverse perspectives and networked experts and respond to the emerging needs of their audience.

An example of this principle in practice might be user innovation communities (Von Hippel 2001). These groups come together without management oversight and for reasons other than job performance and efficiency to form communities that create new products and ideas. More traditional corporations such as Google, 3M Company, Gore-Tex and others (Sawyer 2008) often attempt to imitate the characteristics of these user innovation communities by allowing employees some flexibility with their time and resources so they can pursue emerging projects that are intrinsically motivating to them and meet developing needs of consumers (Google 2008). This flexibility enables workers to chase the moving target that is innovation by encouraging them to work on ideas they feel are interesting, with whom and what resources they think will best help them. This also allows for constantly changing and evolving technologies to support further innovative growth because a flexible design process can adapt to emerging technologies more readily.

Motivation: the hacker work ethic

Members of a COI experience different motivations for their work than members of traditional COPs. Himanen (2001) described this motivation as the hacker work ethic, because it is often prevalent among computer hackers. The term "hacker" has negative connotations, but the term rightfully describes anyone who cares about their craft and finds it intrinsically motivating and compelling. Himanen believed that many modern innovators follow a hacker work ethic, which he contrasted with traditional Protestant work ethics that value work as an obligation to be done by responsible citizens. Instead, Himanen felt that solving complex, real-world problems motivates hackers. He argued that hackers care deeply about their work, are dedicated to producing quality for its own sake, but yet also find their work joyful, intrinsically interesting, and even playful. As a short vignette, he explained the intensity with which hackers engage with their work: "The classic hacker has emerged from sleep in the early afternoon to start programming with enthusiasm and has

continued his efforts, deeply immersed in coding, into the wee hours of the morning." Raymond (2003) explained this motivational philosophy in loyalist terms: "You have to be loyal to excellence. You have to believe…[it is] worth all the intelligence and passion you can muster…you need to *care*. You need to *play*. You need to be willing to *explore*." Whether the community is engaged in research, programming, marketing, teaching, or learning, finding problems that are interesting and enjoyable to solve often leads to innovative solutions.

Contrasting models

To understand the distinctions in this COI model, it might be helpful to compare it with COP model, which is dominant within the fields of business, learning sciences, and instructional technology (see Fig. 2). I make this comparison only after two caveats. First, I do not assume that one model is preferable to another, only that they promote different kinds of learning and working based on a conception of what is mutually shared, either shared practice or shared innovation. My argument is that COP models are very effective in some situations, but that our evolving innovation economy requires us to also consider the need for communities whose primary focus is on innovation. Second, the lines of demarcation between the two models are not often clear. Many COP sometimes function as a community of innovation, and some COIs, after developing an innovation, morph into a COP to implement the innovation. Thus, these models have many overlapping features, which is natural, since they are based on similar social learning theories. Nevertheless, in order to understand the implications of the two models, it is necessary to emphasize the differences.

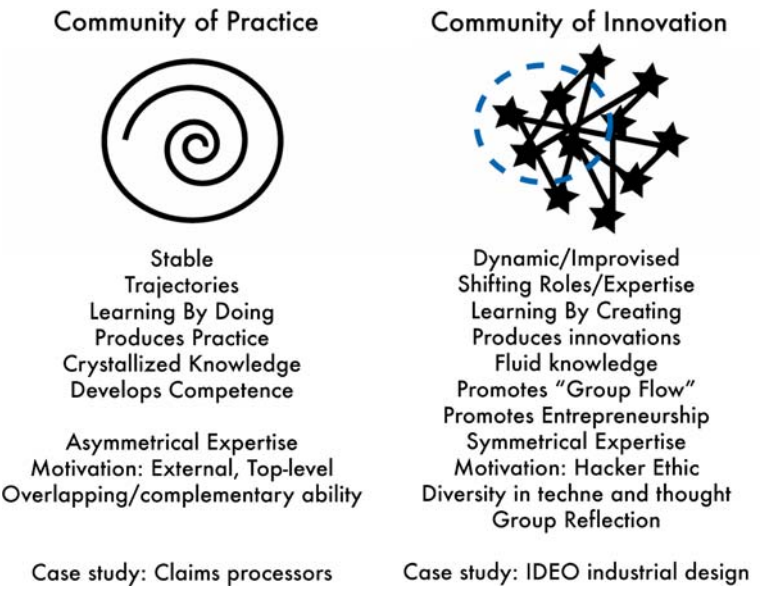

Fig. 2 A comparison of COP and COI models for formal and informal learning. This comparison is drawn from authors cited in this paper. The iconic images are my own, representing how I visualize the differences between the two models. For COPs, novices are mentored into a community as they follow a trajectory of gradually acquired expertise until they are experts within the group. For COI, boundaries are less clear, the community more dynamic and evolving, and expertise more asymmetrical

To contrast these two models, I refer to Wenger's (1998) own example of a typical COP comprised of insurance claims processors. This community is stable, in that Alinsu (the company in the case study) will still have the community of insurance claims processors years from now, even though some individual members of the community may come and go. This profession emphasizes efficiency, which Wenger shows by detailing the penalties for phone calls over 15 min, the blazing typing speed of one of the members, and the frequent monitoring of how much time it takes to complete claims. In fact, reaching "production" goals early "is something worth announcing to your neighbors" (p. 33). Participants interact with each other frequently in this community, but the knowledge shared is often procedural. "Medical claims processing…is very much focused on procedures" (p. 40).

Members of this community, as they develop expertise, become more proficient at the set of tasks that define their practice. Their knowledge, while ever growing, is thus somewhat crystallized into one area of expertise. Because of the focus on competency, the community's expertise is hierarchical, as is the leadership, which we learn about on the first page of the vignette when the protagonist moans the lack of privileges from being only a "level 6" (p. 18). The participants' roles within this community are well defined, and their trajectory and role in the community is clear: As they become more efficient and acquire more procedural knowledge and skills, they will progress to higher levels in the hierarchy and mentor the newer members.

In comparison, a typical community of innovation might be the IDEO industrial design company, a leading design consultancy based in Palo Alto, California. Whereas the insurance claims processors were a stable community, IDEO design groups are much more dynamic. When IDEO begins a new project, it assembles a diverse community made up of its own employees and managers, as well as social scientists, architects, engineers, cognitive psychologists, and even CEOs (Nussbaum 2004). Some members may be pulled from outside of IDEO to participate in this community, and when the project is over, the members disband to join other design projects or to return to their former professions.

Once a particular design group is formed, the members participate in "managed chaos" (Nussbaum 2004) as they research the context of the problem and collaboratively brainstorm a solution. During this process, there is no hierarchy, and expertise is distributed asymmetrically. All members of the group contribute ideas and receive equal consideration. With many members working on a problem that stretches the normal definitions of their professions, they learn to adapt their knowledge to fit new contexts. After brainstorming, the best ideas are rapidly prototyped and developed for evaluation. Participating clients learn answers to their marketing and strategic planning problems through this process of collaboratively and iteratively working with IDEO to create solutions. Observers have said that the process is fun, exciting, and very informative, and many are intrinsically motivated to continue the association (Nussbaum 2004).

Learning and working in a community of innovation such as IDEO requires members to have high levels of self-regulatory, metacognitive, and cognitive abilities, as well as social/emotional skills. These are necessary because COIs are less restrictive and more entrepreneurial. This leaves the COI members with first, the task of identifying problems that might not be clearly defined while, second, motivating, regulating, and pushing their efforts to solve the problems. Today's schools, which still emphasize the Industrial Age-model of efficiency over creativity and problem solving, often do not teach these skills (Reigeluth 1994). However, members of innovative communities must successfully learn these adaptive, dynamic abilities (Hakkarainen et al. 2004).

Not all professions consist of COIs, but many do, and yet we still lack the theoretical frameworks to understand these COIs. Perhaps because the construct has not been thoroughly researched, understanding the principles of what enables or fosters a COI requires synthesizing many disparate bodies of research, as I have done in this paper. From the social learning movement, we learn how knowledge is negotiated externally to an individual through interactions with an environment and other persons. We also learn that many kinds of knowledge are situated in particular contexts or held within the shared practices of a community. My assertion in this paper is that other kinds of learning and expertise are gained through shared innovation within communities. Also, technological affordances of the Information Age (ubiquitous access to information and communication) require us to reconsider our models of social learning and working. Accordingly, because of these technologies, modern COIs can be expected to exist in virtual or at least blended (online/offline) settings, and "presence" will be measured more psychologically than physically.

From creativity research, we have learned that innovation can be developed within individuals and groups. Innovation can be partially understood as a function of cognitive processes, although harnessing these processes is terribly complex. Finally, we have learned that innovation has a powerful social component, and that there are discernible processes to group innovation. An innovative group engages in divergent thinking (idea generation), convergent thinking (idea selection), and idea or artifact development and implementation. During each of these processes, the group climate must encourage entrepreneurship and yet interdependence, group reflection, dynamic (progressive) expertise, and intrinsic motivation. In addition, there must be enough trust and psychological closeness among the community members to be able to share new ideas freely, and yet enough diversity to force consideration of alternatives.

Implications for research

As a framework, this conceptualization of COIs is still very basic. There are many unanswered questions, leading to a need for future research. The first step is understanding that a community focused on shared innovation is similar, but not identical to, communities that have shared learning or shared practices. Once we can conceptualize a community of innovation as something unique, we can develop research studies to increase our understanding of these communities. In this paper I have attempted to accomplish this first task of operationalizing COIs as a unique kind of community.

The next step is to develop a research agenda for studying COIs. Many of the empirical questions about COIs can be grouped into three main categories of research questions. As depicted in Table 1, researchers could seek to first answer *What are Communities of Innovation?*; secondly, *What are the effects of these communities?*; and finally *How can we foster or design these communities?* With the first group of questions about the nature of COIs, researchers would benefit from developing thick case studies of actual COIs. Currently, many such case studies exist for learning communities and COP, but few such case studies of COIs exist outside of motivational self-help books on creativity. In seeking to understand what COIs are, social network analysis (Wasserman and Faust 1994) could be beneficial as a tool for quantifying the social capital and communication networks making up COIs. Social network analysis quantifies the strength of communicative links between different persons, thus developing an overall picture of the collaborative patterns and key persons within communities. This research methodology could help identify "innovation champions" (Coakes and Smith 2007) and patterns of collaboration, interaction, and

Table 1 Research agenda for studying COI

Categories	Example research questions	Methods
What are COIs?	1. What are the characteristics of a COI? 2. How do members of a COI interact? How do they share tacit/explicit knowledge? 3. How do members engage in divergent/convergent thinking cycles? 4. How much of a COI is a sum of individual talents and how much is it something new? 5. What is the nature of group flow? 6. Are COIs inherently blended, online, or physical communities? Does the nature of a COI change in different online/physical settings?	Ethnographic case studies Social network analysis Conversation analysis
What are the effects of COIs?	1. Are COIs more creative than individual creativity? 2. How do shifting roles and entrepreneurial expectations impact identity development of members? 3. How is domain knowledge gained through shared innovation? 4. Do COIs develop the personal creative potential of their members?	Standardized creativity tests Creativity expert review Critical incident technique Grounded theory
How can we foster COIs?	1. What attributes of members create the most effective COIs? 2. How can COI members transfer and build upon expertise? 3. What environmental, leadership, and policy attributes best enable COIs to develop? 4. What technologies facilitate innovative communications and work?	Case study Grounded theory Experimental methods

knowledge flow in innovation communities (Dahlander and Wallin 2006). While social network analysis would provide a broad consideration of a community, researchers could use conversation analysis to microanalyze the communication patterns of members working towards shared innovation. This method has already successfully helped us understand many aspects of group creativity and group flow (Sawyer 2008).

To answer the second set of questions about the effects of COIs, researchers would need to validate the positive or negative outcomes of a COI. To consider the effectiveness of the community in developing individual creative potential, a standardized creativity test such as the Torrance Test for Creative Thinking (Kim 2007) would be useful in designing experimental studies. To look instead at the innovative product developed by the community, a common approach is to employ expert judges, using a reliable protocol, to evaluate the product. For a more qualitative approach, the Critical Incident Technique (Flanagan 1952) is a useful tool for understanding patterns in the critical moments of a person's experience. In researching COIs, this technique could be used to understand the critically creative "ah-hah" moments involved in innovation, and the collaboration occurring during those moments. Finally, grounded theory methods (Glaser and Strauss 1967) could be used to inductively develop theory about the effects of COIs on its members. This method is effective in developing theory cyclically through the thorough study of the participants involved in a situation. In the case of COIs, grounded theory methods could be used to develop understanding of how members participate/collaborate in a COI, how they are motivated and managed, how the environment challenges or supports the developing innovations, and how ideas emerge from their members' interactions. These findings could then be used to guide the design and development of effective COIs.

Perhaps most challenging would be to research how to foster COIs, although this is an important area to study. Qualitative methods could be used to tease apart the attributes of members and of environments that best enable the emergence of a COI, and experimental methods could then be used to test for the relative importance of each attribute until a more coherent framework of essential attributes is found. These attributes could then become guiding principles for designing COIs.

Implications for design

As we further our understanding of the nature of COIs and how they can be developed, there will be many implications for instructional designers and educators. Following a COI model would influence how a teacher or designer planned the environment, activities, and organization of people. In developing the environment, a designer would think beyond traditional time/spatial boundaries as COIs redefine these traditional boundaries (Benton and Giovagnoli 2006). Designers would instead need to enable easy sharing of knowledge or expertise with other members of students' social networks, whether within or without the spatial boundaries of the school or classroom. Time boundaries should also be blurred, allowing students to find a flow-like experience as a group and to work within that optimal learning/working experience as long as needed. Small design choices such as providing easy communication access to all members of the community, utilizing emerging social networking technologies, and providing access to design technology and resources on demand should more easily enable COIs to emerge.

Besides considering the environment, designers of a COI should create activities where students have autonomy in developing projects that are intrinsically interesting to them and that solve real-world, complex problems. Learning activities would build progressively upon each other, and would require the learners to continually push themselves into new territories, where they could gain new skills and expertise and learn to be adaptable and flexible. Also, group and personal reflection should become a valued component of the learning environment. Incentives should be group-based, so that sharing ideas and insights, and improvising from each others' thoughts, is encouraged. Finally, designing for a COI involves organizing the right mix of people so that diverse perspectives feed off each other. As in traditional COPs, a strong psychological community needs to be fostered where members trust each other, appreciate their diversity, and, perhaps most critically, value their interdependence for accomplishing their goals.

Designing and researching environments that embody these principles will challenge us, because it will produce classes, schools, trainings, and organizations very different than what we are used to. The requirements of a new creative and collaborative economy, however, demand that we meet these challenges.

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