

The Learning Concept Within Innovation Systems Theorizing: A Narrative Review of Selected Publications on National and Regional Innovation Systems

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Received: 3 October 2013 / Accepted: 16 June 2014 /
Published online: 4 July 2014
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Abstract Learning is highlighted as key to innovativeness in the innovation systems literature, yet there seems to lack clarification about the meaning of learning in the literature. There is thus a need for a systematic scrutiny of how the concept of learning has been used. In an attempt to address this issue, this paper offers a narrative and longitudinal critical analysis of 29 articles, pertaining to parts of the literature about national and regional innovation systems. Due to differences in main assumptions, foundations, and vocabulary, we have found it useful to categorize these works into five theoretical streams: Interactive Learning, Learning Economy, Innovation Modes, Knowledge Bases, and Political Economy. These streams operate with vague definitions of learning (if defined at all). There is neither a uniform usage of the term learning nor a strong connection to existing learning theories of other disciplines. Subsequently, we have developed five suggestions on how to relate this indigenous learning concept to relevant learning theories from educational science and organization theory literature. By doing so, we seek to contribute to more sophisticated theories regarding innovation systems and the centrality of the learning concept.

Keywords National innovation systems · Regional innovation systems · Learning · Narrative literature review

Introduction

The concept of learning has figured prominently in approaches that theorize the composition and function of innovation systems, as exemplified by the axiom that if knowledge is the fundamental resource, learning becomes the most important process (Lundvall 1992). However, several authors have commented about the seeming lack of explicit focus on the meaning of learning in innovation system theorizing, despite the perceived importance of learning in these approaches (Ellström 2010; Miettinen 2013; Uhlin 2001). Even some

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main proponents of the approaches acknowledge that a lack of clarity regarding the learning concept may constitute a problem (Cooke 2007; Lundvall 2004). For innovation systems approaches to continue to develop while emphasizing the centrality of learning, it makes it worthwhile to address systematically how the term learning is used in the approaches. So far, no such systematic review has been conducted, although some works have scrutinized the theoretical foundations of these approaches in more general terms or based on a few select references. We contribute to this body of meta-theorizing by conducting a longitudinal narrative review, inquiring how the concept of learning is defined and used, and exploring the theoretical bases for these usages throughout the existence of these approaches. We thus aim at providing answers to two descriptive questions:

- What are the assumptions regarding why learning is important and how it occurs?
- What are the theoretical foundations in applying the concept of learning?

The literature on innovation systems has become a voluminous and internally heterogeneous field. We have selected parts of this field, that is, the national innovation systems (NIS) approach often known as the “Aalborg variant” due to many lead authors including B.Å. Lundvall being based at the Aalborg University, and key authors in the regional innovation systems (RIS) literature. Based on the result of this analysis and mapping exercise, we argue that there emerged and have persisted five rather distinct groups or streams of theorizing:

- Interactive Learning stream,
- Learning Economy stream,
- Innovation Modes stream,
- Knowledge Bases stream, and
- Political Economy stream.

These streams have emerged gradually, with several authors shifting from one stream to another, and some streams existing in parallel. Several later streams build at least partially on previous or parallel streams. The two streams of Innovation Modes and Knowledge Bases appear to dominate the current discourse on NIS and RIS, respectively. Each stream has operated with its own concept of learning. While such heterogeneity in itself is not necessarily an issue over the short term, it could become a problem, especially if these systems’ approaches are assessed as influential in the general theorizing on innovation.

This paper is structured as follows. First, we explain the methodology and delimitations of our own study, including a brief mention of previous commentaries on the emerging literature on innovation systems. Then, we present the findings for the two research questions and conclude by reflecting on how the two sub-approaches of innovation systems theorizing may be improved in terms of the usage of the learning concept.

Methodology

The innovation systems literature was selected and analyzed using a seven-step process. First, we realized that an analysis of the entire range of the innovation systems literature

would go beyond the resources and scope of this particular study. Since the relevant literature has diversified into various traditions or sub-fields (Soete et al. 2010), our approach has been to delimit the focus. There are three variants of the NIS concept, each one associated with the “founding fathers” C. Freeman, B.Å. Lundvall, and R. Nelson (Fagerberg and Sapprasert 2011; Soete et al. 2010). Additionally, during the 1990s, there emerged perspectives framed as RIS, as well as “social innovation systems,” “sectoral innovation systems,” and “technological innovation systems.” In this paper, we sacrifice scope for depth and focus on only two of these traditions because they seem to pay special attention to the role of learning in innovation systems; the NIS variant associated with B.Å. Lundvall, B. Johnson and colleagues, and the RIS approach associated with P. Cooke, and B. T. Asheim and colleagues.

Second, we used existing meta-theorizing articles (Balzat and Hanusch (2004), Doloreux and Parto (2005), Edquist (2005), Fagerberg and Sapprasert (2011), and Soete et al. (2010)) as the basis for selecting several authors as central to the two chosen sub-approaches, since all offered overviews and discussions about the field. Sharif (2006) described the institutional and biographical origins of the NIS approach. At the end of this step, we reconfirmed that B.Å. Lundvall and B. Johnson were two of the key authors supporting the learning-focused variant of NIS, and B.T. Asheim and P. Cooke were two of the key authors endorsing RIS.

Third, we selected for analysis a total of 29 articles and book chapters (13 from NIS and 16 from RIS). These were single or co-authored works and interpreted as seminal, that is, highly cited, based on searches on Scopus, Web of Science, and Google Scholar, and especially relevant among the authors’ publications in terms of the issue of innovation and learning. We also included less cited articles and book chapters, either because they explicitly dealt with issues related to learning within innovation systems or were recent publications of key authors. The articles listed in Table 1 are sorted according to the classification resulting from our analysis in steps 4–6 (explained below).

The fourth through sixth steps involved the analysis itself and corresponded to the research questions presented in the introduction. The fourth step entailed mapping the main assumptions within the 29 articles and book chapters, that is, why learning is assumed to have an important role in the innovation system. In the fifth step, we investigated how the concept of learning was actually used, that is, we mapped the definitions used, if any, regarding learning. The sixth step comprised mapping the theoretical bases of the assumptions and definitions revealed in the previous two steps, that is, the main sources of inspiration within general learning and organizational theory exogenous to the innovation systems literature, for instance. We were thus interested in identifying intellectual “turning points” (Chen 2004), although we conducted an interpretative tracking rather than a full-fledged bibliometric analysis. Based on our interpretations from the fourth through sixth steps, we arrived at the classification in Table 1.

The seventh and final step consisted of formulating some implications drawn from the descriptive aspects of the study as a basis for critical but constructive suggestions regarding the further evolution of the innovation systems literature.

Our study thus corresponds to a narrative literature review (Baumeister and Leary 1997) and differs from the traditional and comprehensive literature reviews of a particular field, since we aim to focus on a particular and possibly problematic concept within the field. Our study also differs from the reviews cited above by being delimited

Table 1 Literature selected for review, classified according to five streams of theorizing

NIS	RIS
Interactive learning stream	Interactive learning stream (cont.)
Johnson (1992)	Asheim (1996)
Lundvall (1985)	Asheim and Cooke (1999)
Lundvall (1988)	Asheim and Isaksen (1997)
Lundvall (1992)	Asheim and Isaksen (2002)
	Coenen et al. (2004)
	Cooke (1992)
	Cooke and Morgan (1994)
Learning economy stream	Knowledge bases stream
Gregersen and Johnson (1997)	Asheim and Coenen (2005)
Johnson et al. (2002)	Asheim and Gertler (2005)
Johnson (2011)	Asheim et al. (2007)
Lundvall (2004)	Asheim et al. (2011)
Lundvall and Johnson (1994)	Asheim (2012)
Innovation modes stream	Political economy stream
Jensen et al. (2007)	Cooke et al. (1997)
Lundvall (1998)	Cooke et al. (1998)
Lundvall et al. (2002)	Cooke (2001)
Lundvall (2007)	Cooke (2007)

to selected authors within the particular field, while attempting to follow the long-term development of these authors' works. On the other hand, while we have found considerable inspiration in several existing commentaries on the innovation systems literature, our study differs from these in that they are based on a single or a very limited number of works (Ellström 2010; Meeus and Faber 2006; Uhlin 2001), whereas we treat the intellectual developments more comprehensively using a longitudinal method. Moreover, existing commentaries tend to focus solely on NIS (Miettinen 2013) and do not examine NIS and RIS in conjunction, as we have done.

Assumptions Regarding Learning Within the Five NIS and RIS Streams

The Interactive Learning Stream

The notion of interactive learning is at the heart of both the earliest and later theorizing on innovation systems, and it may seem peculiar to operate with a separate Interactive Learning stream. We nevertheless do so to draw attention to the foundational works within both NIS and RIS in the late 1980s and early 1990s. Lundvall (1985, 1988) used neither the term NIS nor interactive learning, but he introduced learning-by-combining and learning-by-interacting in the 1985 paper. The latter concept refers to instances where, for example, “geographical and cultural proximity might give the users more direct and easy access to information from domestic producers. Both users and producers are learning-by-interacting” (Lundvall 1985, p. 27). The concept is clearly a forerunner of interactive learning, which becomes central to later developments of the approach. By 1992, Lundvall (1992) outlined the status quo for this variant of the NIS approach as resting on two sets of assumptions; the first is that learning is the most

important process in the modern economy, since knowledge is the most important resource. The second assumption observes that learning is predominantly interactive, and it is therefore “a socially embedded process which cannot be understood without taking into consideration its institutional and cultural context” (Lundvall 1992, p. 1). The generation of innovation is generally an uncertain process, since innovations may not be predicted or planned in advance. Due to the centrality of learning within this uncertain process, “complex communication between the parties involved” (Lundvall 1992, p. 3) is necessary, especially when the exchanged knowledge is of a tacit kind. Johnson (1992) stated in a similar fashion that almost all learning is done as some form of interaction, and it is therefore to be considered as a social process (pp. 31–32).

Much RIS research built on NIS-related developments, but while the early works of Freeman (1987) and Lundvall (1988) on NIS were found useful, the relative generality of their concepts regarding NIS was assessed as follows: “their blind spot about regions were obvious weaknesses in what was nevertheless path-breaking work. What was becoming clear was that there was a distinct need for new and detailed empirical research inside firms and innovation support organizations” (Cooke 2001, p. 952). However, the notion of interactive learning was clearly influential in the establishment of the RIS type of theorizing as well. The future of industrial districts is conditioned by their transformation into “learning regions” (Storper 1995), where innovation processes are perceived as socially and territorially embedded, interactive learning processes (Asheim 1996), and where learning from close interaction with successful growth regions fosters innovation, as other regions learn to build their own models of development (Cooke 1992). Interactive learning is fundamental (Asheim and Cooke 1999) to a bottom-up, interactive innovation model (Asheim and Isaksen 1997). Furthermore, building on Camagni (1991), a localized pattern of development facilitates a collective learning process, such that information, knowledge, and best practice are rapidly diffused throughout the local milieu, raising the creative capacity of both firms and institutions. Hence, innovation is increasingly a collaborative learning process (Cooke and Morgan 1994), with place-specific, contextual knowledge (Asheim and Isaksen 2002) and proximity (Coenen et al. 2004) as facilitators for interactive learning. Cooke (2001) has also remarked that “learning is, of course, the central attraction where knowledge capital can have rapidly escalating value” (p. 970).

The Learning Economy Stream

Lundvall and colleagues also focused on developing a general theory of innovation by introducing the concept of “the learning economy” (Lundvall and Johnson 1994). What had started out as an abstract maxim concerning knowledge as the important resource and learning as the important process (Lundvall 1992) was developed into theorizing the various components within such a process. Lundvall and Johnson (1994) reflected on the institutional setup of modern capitalism in order to develop a conceptual framework that provided “knowledge and learning the central roles they deserve in the analysis of economic change” (Lundvall and Johnson 1994, pp. 23–24). However, the instance closest to a definition of learning was to envision it as a flow that increases knowledge, since “almost all learning is interactive” (p. 28). In contrast, the authors were more detailed regarding the concept of “learning capabilities” which they referred to as the increased importance of “networking with other firms [and] horizontal

communication patterns and frequent movements of people between posts and departments” (Lundvall and Johnson 1994, p. 26).

Johnson (2011) summarized the main traits of the NIS perspective as observed in relation to the learning economy thesis, pointing out the NIS approach as representing a shift from regarding the market predominantly in terms of transaction costs to “learning benefits” (p. 704). Innovation is rooted in different kinds of “learning relationships” (p. 705), such as those between users and producers, those among people with varying types of competencies, and those among different departments in firms (p. 705). “[S]ince learning is fundamentally interactive, it requires a degree of social cohesion and trust to thrive” (p. 707).

Lundvall and Johnson (1994) claimed that companies to a large extent need to be learning organizations (Lundvall and Johnson 1994, p. 26). Although the authors acknowledged that all economies are to some extent learning economies, they stressed the increasing importance and scope of learning, as well as the need for firms to start to “learn how to learn” (Lundvall and Johnson 1994, p. 26).

Lundvall and Johnson (1994) evaded an outright definition of learning, since “for an industry economist it is a risky enterprise to enter a discussion on how to define knowledge and learning” (p. 27). However, they introduce instead a taxonomy where “economically relevant knowledge” (p. 27) is grouped into four broad categories; facts (“know-what”); scientific principles (“know-why”) specific and selected social relations (“know-who”); and “the capability to do different things on a practical level” (“know-how”) (Lundvall and Johnson 1994, pp. 27–28).

The Innovation Modes Stream

Within the NIS school, several authors eventually developed an approach that we have called the Innovation Modes stream. In works antecedent to arriving at the innovation modes concept, some authors experimented with expressions such as “national styles” of innovation (Lundvall 1998) and “national systems of production, innovation and competence building” (Lundvall et al. 2002), where learning is synonymous with “the production of intellectual capital” (which in turn “is strongly dependent on social capital”) (Lundvall et al. 2002, p. 225). They subsequently published a more elaborate, two-dimensional ideal type intended for measuring modes of innovation (Jensen et al. 2007; Lundvall 2007). This stream’s central assumption is that firms and economies may vary according to the intensity in which they practice one out of two modes of innovation, where science, technology, and innovation (STI)-based innovation is one mode, and doing, using, and interacting (DUI)-based innovation is the other mode. The STI mode is “based on the production and use of codified scientific and technical knowledge,” whereas the DUI mode “relies on informal processes of learning and experience-based know-how” (Jensen et al. 2007).

The basis for constructing the ideal type is the distinction between two basic types of knowledge - tacit and codified: “A key difference between firms, sectors, regional and national systems is the role played by respectively codified knowledge and tacit knowledge in the innovation process” (Lundvall 2007). Building on this basic distinction, they distinguished further among the four knowledge types mentioned above: know-what, know-why, know-how, and know-who. Each of these has its own “mechanisms through which learning different types of knowledge takes place” (Jensen et al. 2007). Whereas

know-what and know-why are most closely associated with the STI mode, know-how and know-who are most closely related to the DUI mode of innovation.

Jensen et al. (2007) subsequently gave examples of how each knowledge type may be acquired, ranging from reading books and attending lectures to accessing databases in the case of know-what and know-why, and from apprenticeship relations to “social practice and... in specialized education environments” (p. 682) in the case of know-how and know-who.

Jensen et al.’s work (2007) turned out to be the main reference point for the Innovation Modes stream; however, the simultaneous Lundvall (2007) publication elaborated on the relationship between learning and innovation by way of listing six of “the assumptions linking knowledge and learning to innovation systems”: elements of knowledge embodied in the minds of people, in routines of firms, and in relationships among people and among organizations; learning and innovation as the outcome of interaction; “interactionist” (Lundvall’s quotation marks) as the most basic characteristic of the innovation system approach; and insufficiency of a purely economic analysis, since interactive learning is a socially embedded process. Thus, “learning and innovation are strongly interconnected (but not identical) processes” (Lundvall 2007, pp. 106–107).

The Knowledge Bases Stream

The Knowledge Bases stream within RIS builds on the Interactive Learning stream, but adds knowledge bases as a new dimension, where creation and renewal of skilled labor and knowledge are regarded as a central aspect of regional learning processes (Asheim and Gertler 2005). This stream developed from the mid-2000s and continues until now. First, it argued that different types of RIS are contingent on the accessible regional knowledge infrastructure and the industry knowledge base—the analytical base of scientific codified knowledge for radical innovation or the synthetic base of tacit knowledge and practical know-how for incremental innovation (Asheim and Coenen 2005). These knowledge bases were later extended by a symbolic base (learning through interaction in the professional community or with “border” professional communities) (Asheim et al. 2007) for a more nuanced understanding of spatial implications for face-to-face communication and “buzz” (p. 655) for learning and innovation. These differentiated knowledge bases were then used in combination with two other key concepts, related variety and policy platforms, to provide a new policy framework for regional innovation (Asheim et al. 2011). In this view, learning and knowledge transfer are facilitated when there is technological relatedness between sectors so that cognitive distance is neither too great for learning to occur nor so close that novelty is hampered. Finally, in a re-examination of the changing role of learning regions, Asheim (2012) bridged the three differentiated knowledge bases with the two modes of innovation, DUI and STI, in order to understand how to reduce cognitive distance and increase connectivity and thereby stimulate learning within regions.

The Political Economy Stream

The Political Economy stream consists of articles based on evolutionary economics from the late 1990s and early 2000s. This stream initially shared many of the same ideas as those of the Interactive Learning stream in terms of emphasizing learning as interactive and institutionally embedded (Cooke et al. 1997, 1998). However, in the

2000s, works highlighting a more critical view emerged. By 2001, Cooke started to consider “the conditions and criteria for empirical recognition and judgement as to whether scientifically analyzed, concrete cases of innovation activity warrant the designation of regional innovation system” (Cooke 2001, p. 945). The Political Economy stream explicitly distanced itself from the Knowledge Bases stream and particularly from the Interactive Learning stream. For example, Cooke (2007) argued that learning and innovation are opposites, and innovation requires organizational change. He further claimed that the RIS approach “is not particularly predicated on *learning*, not even referencing such literature at the outset (Cooke 1992), but rather on *knowledge* and *innovation*” (Cooke 2007, pp. 184, his italics). Cooke (2007, p. 184) asked why learning discourses have failed and why “the promise of learning—and particularly in this context—‘learning regions’ has waxed and then waned so swiftly?” One problem is the urge to develop new “learning” propensities without organizational reform, another is the broad usage of the “innovation system perspective,” and the third is that much of the literature has operated with a too broad notion of learning, resulting in blurred findings: “the aspiration normatively to urge a learning predisposition upon agents in such complex organizations as regions seems hard to critique, nevertheless on closer inspection the focus is so blurred, the means so attenuated, and the organizational metamorphosis so daunting that the injunctions end up being meaningless” (Cooke 2007, p. 200).

Theoretical Foundations of the Five NIS and RIS Streams

After having described the main traits of the five streams of literature in the preceding section, we now examine the theoretical bases for each stream. We investigate the types of theories that each stream builds upon, with a special focus on whether there are any references to relevant fields outside economics and economic geography, such as organization theory, philosophy, and educational sciences (Fig. 1). We inform about cited authors’ initials and surnames, but are unable to provide full references due to space considerations.

The three NIS-related streams evidently have a canon of referenced authors, including K. Arrow’s work on learning by doing (LBD) and his notion of the limits of organization, N. Rosenberg’s work on user learning, and E. von Hippel’s as well as R. Rothwell’s work on user innovation. References to these authors are scarce in the RIS-related streams, but the Political Economy stream references K. Arrow (Cooke 2007) as well as N. Rosenberg and R. Rothwell (Cooke et al. 1998), the Interactive Learning stream has one reference to R. Rothwell (Cooke 1992), and the Knowledge Bases stream has one reference to E. von Hippel (Asheim et al. 2007). On the other hand, the RIS-related, Interactive Learning stream has a canon of its own in economic geographers such as R. Camagni, M. Bellandi, and S. Brusco, as well as O. Weinstein on flexibility.

We can identify two instances of watersheds, where the first is between the first- and second-generation NIS and RIS streams and consists in starting to cite M. Polanyi and the work of I. Nonaka and H. Takeuchi, signifying the increased interest in the role of tacit knowledge. However, there are no citations of supplementary work on tacit knowledge, except for the Innovation Mode and Knowledge Bases streams’ references to the organizational theorist A. Lam’s (2000) attempt to develop aspects of the I. Nonaka and H. Takeuchi framework (Asheim and Gertler 2005; Jensen et al. 2007). To our surprise, none of the streams/29 articles reflects any of the parallel, fast-growing, and extensive research

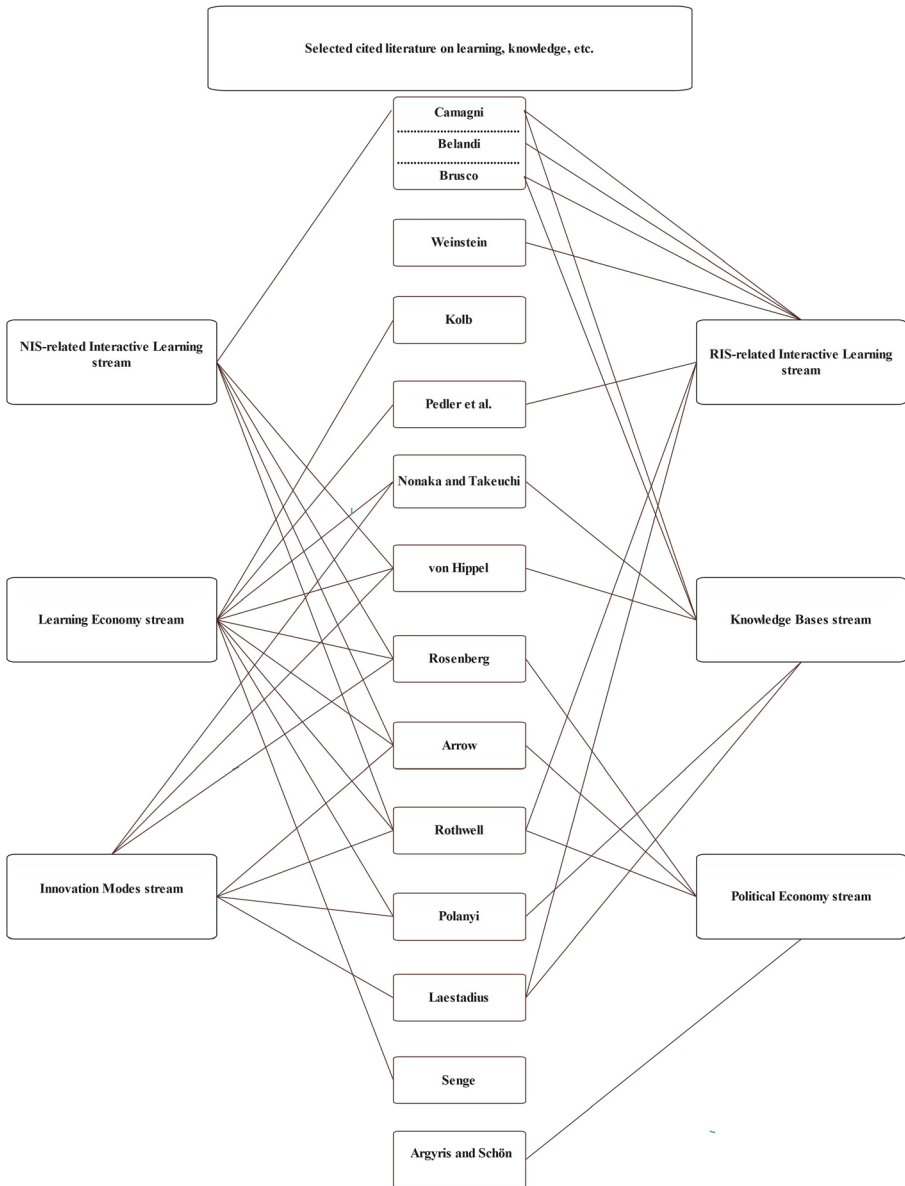


Fig. 1 Partial intellectual mapping of national and regional innovation systems literature line change recommended. Note: Consult Table 1 for information about publications classified into each stream

conducted on the role of knowledge in organizations, such as the widely cited works of F. Blackler, R. Grant, and J.C. Spender regarding knowledge and the firm. The second watershed occurs between the second- and third-generation NIS streams and between the first- and second-generation RIS, in that they start citing S. Laestadius. This is due to both the Innovation Modes and the Knowledge Bases streams using S. Laestadius’ distinction between analytical and synthetic knowledge as their starting points after having been briefly introduced in the Interactive Learning stream (Coenen et al. 2004).

Regarding outright *educational science literature*, we find the Learning Economy stream's references to D. Kolb. However, Johnson et al. (2002) and Lundvall (2004) only mention Kolb's book on experiential learning in passing, rather than incorporating and developing this author's ideas about experiential learning. Lundvall also once reflects within the Innovation Modes stream that: "Actually the NSI [aka NIS] approach has elements in common with the social psychological pragmatist school of Chicago and not least with the ideas of George Herbert Mead and John Dewey" (Lundvall 2007, p. 107). These assumed commonalities are, however, not made any more explicit or discussed. Some other directly cited works from within educational science are not included in Fig. 1 due to limited space. However, in the Knowledge Economy stream, both Johnson et al. (2002) and Lundvall (2004) cite A. Hatchuel and B. Weil regarding the development of expertise, while the former work also cites H. Dreyfus and S. Dreyfus on expertise as well as J. Lave's foundational work in sociocultural learning theory. In the Knowledge Bases stream they mention, but do not make into support for an explicit learning stance or definition of their own, the foundational works within sociocultural learning theory by E. Wenger, J.S. Brown, and P. Duguid, which established the concept communities of practice (Asheim and Gertler 2005). The workplace learning researcher P. Ellström is also mentioned in passing (Asheim 2012). The Political Economy stream once mentions the learning theorist L. Dirckinck-Holmfeld (Cooke 2007).

The situation is similar when it comes to references to *organizational learning literature*. Somewhat ironically, the Political Economy stream article by Cooke (2007), which is mainly a critique of the learning concept within RIS, is the only article (out of 29) that cites the classic work by Argyris and Schön (1978). However, an article in the Innovation Modes stream mentions the work of management theorists such as H. Mintzberg on the structure of organizations, and T. E. Burns and G. E. Stalker's 1961 classic on the management of innovation (Jensen et al. 2007),¹ whereas Lundvall (2007) includes references to A. Sen on capabilities, C. Gresov and L. Donaldson on contingencies, and R. M. Burton and B. Obel on organizational design. The Knowledge Bases stream is the only one referring to a seminal work within the organization theory by B. Kogut and U. Zander (Asheim 2012). The Political Economy stream is the only one to cite the seminal article on exploration and exploitation of knowledge by J. March (Cooke 2007), as well as citing H. Itami and T. W. Roehl on mobilizing invisible assets (Cooke et al. 1997, 1998), as a part of the stream's intention to advance the field from "learning regions" to "knowledge economy regions" conceptualizations. In contrast, the literature applying the normative learning organization perspective has been more popular, as seen in the citations of M. Pedler et al.'s book about the learning company, cited in Asheim (1996), Asheim and Isaksen (1997), and in Lundvall and Johnson (1994), and P. Senge's book about the learning organization, cited in Lundvall (2004, 2007).

The mapping has thus confirmed, albeit in a simplified form, that the five streams follow specific channels of inspiration. The first-generation, Interactive Learning stream is in overall largely internalist in its theoretical foundations, with its learning concept based on the work of economists and economic geographers, respectively, in the two branches of the stream. The second-generation, NIS-related, Learning

¹ Jensen et al. (2007) also included several references to industrial relations and human resource management literature, such as A. Lam, P. Osterman, S. Wood, and the H. Ramsay group.

Economy stream maintains its economic basis but expands its scope significantly by starting to discuss the role of tacit knowledge, albeit in single articles rather than as a whole. Incidentally, two of the articles within the stream (Gregersen and Johnson 1997; Lundvall and Johnson 1994) that present and discuss learning most fervently contain no references whatsoever to educational science or organizational learning literature. The second-generation, RIS-related Knowledge Bases stream and the third-generation, NIS-related Innovation Modes stream focus on tacit knowledge at the same time as they start their S. Laetadius-based frameworks. The third-generation, Political Economy stream cites most widely the learning and organizational learning literature in one of its papers (Cooke 2007), but doubts the value of basing its further approach on the learning concept and appears to depart from the other streams.

Critique of Current Practice and Suggestions Regarding Future of NIS and RIS Theorizing

The previous sections have described the main assumptions regarding learning and the theoretical bases of the five streams. We have described and analyzed these on their own terms and have found no consistent definition or usage of the term learning among the streams. In fact, there is rarely any definition or elaboration at all of this crucial term within any of the streams. Subsequently, this section lists five suggestions regarding future NIS and RIS approaches. We focus in sequence on educational science and organization theory, respectively.

Insights and Suggestions Based on Learning Perspectives from Educational Science

In educational science, there is a fair amount of consensus on the definition of learning as a process, through the acquisition of either knowledge or experience, resulting in relatively lasting behavioral changes (Wakefield 1996). A series of more sophisticated perspectives on how learning occurs have been developed over the years. One basic contemporary framework concerns the subdivision among three perspectives: behaviorist (theorizing learning as responses to stimuli), cognitivist (theorizing learning as acquisition of knowledge), and sociocultural (theorizing learning through participation in social activities) (Greeno et al. 1996). These three perspectives address the basic pedagogical questions regarding types of learning: who the learner is, what is being learned, and how it is being learned. The three perspectives may briefly be described as follows. First, the behaviorist perspective emerged from the positivist ideals of the natural sciences and assumes that repeated stimuli and responses may result in learning outcomes. Thus, one may imagine a process where initial learning concerns basic facts, whereas subsequent stages can concentrate on reflection and use of the acquired knowledge. Second, the cognitive perspective assumes that learning is a process where a person receives and interprets information, subsequently reorganizes it together with one's accumulated knowledge reservoir, and gradually attains the ability to use one's mental structures toward a new form of understanding. Third, the sociocultural perspective assumes that knowledge is constructed through the ways people interact through practice. Knowledge does not exist in a vacuum but is a part of the social and cultural context. An additional approach of perceiving learning processes is to

focus on the notion of experiential learning, which may transcend the basic categories above. Within this tradition, Dewey (1916/1944, p. 92) coined the phrase learning by doing (LBD) and proposed specific steps on how such a process may occur; Kolb (1984) developed this approach into a model of experiential learning.

Although this method of categorizing types of learning processes is influential, another one with a high potential for inclusion in innovation studies is to theorize about levels of learning. Bateson (1972) made a distinction among primary learning, which involves modifying routines; secondary learning, focusing on problem solving; and tertiary learning, which entails reframing of problems. The sociocultural theory proposed by Engeström (1987) re-termed tertiary learning as expansive learning, since the entire activity in question changes, including the way it is conducted in terms of collaborative relationships (Miettinen 2013, p. 38).

Regarding concrete suggestions based on learning perspectives from educational science, our first recommendation concerns the learning concept itself, that is, the question of adopting or being inspired by the existing definitions in educational science. It puzzles us that neither the general definition introduced above, nor any of the more sophisticated theorizing about types and levels of learning, has been adopted by any of the five streams. One benefit of adopting the general definition regarding relatively lasting behavioral change would be that to some extent, it could offer a standard for measuring whether activities such as “interactive learning” actually constitute learning, as opposed to mere collaboration of other kinds. A further advantage of building on the basic educational definition of learning would be that it opens the door to utilizing the tripartite division among the behaviorist, cognitive, and sociocultural perspectives. Hence, in the context of developing the notion of “interactive learning,” one may ask how such learning leads to lasting behavioral change, as well as whether such learning corresponds to sociocultural (interactive) learning or a combination of this form and cognitively based learning through acquisition of knowledge (sociocognitive learning). The “competence building” perspective prevalent in the Innovation Modes stream (Lundvall et al. 2002), for instance, is too crude to have much analytical strength, since the notion of competence building as learning is not specified in terms of specific types of learning.

Our second suggestion pertains to learning levels. The tripartite thinking about learning levels should be especially relevant for usage within NIS and RIS theorizing, since this framework could illuminate and further theorize the main features of several streams, especially the Knowledge Bases, Innovation Modes, and Learning Economy streams. In other words, what is the level (ranging from primary to tertiary) of the learning relationships within the innovation modes of DUI and STI and within particular types of knowledge bases? From the perspective of learning levels, how did the knowledge bases come into being in the first place, how do they change, and to what degree is there heterogeneity within each knowledge base? And the tertiary learning perspective could be applied to the Learning Economy streams’ theorizing of learning-to-learn processes.

Our third suggestion involves the particular concept of LBD. In the Interactive Learning, Knowledge Economy and Innovation Modes streams, the notion of LBD is prevalent as underpinning interactive learning relationships and the DUI mode of innovation, while the streams refer to K. Arrow’s LBD concept. As already pointed out by Miettinen (2013, p. 37) and Uhlin (2001, p. 315), K. Arrow’s LBD concept

merely implies the achievement of an upward curve based on increased levels of efficiency, and does not have its foundation in terms of learning theory. Further development of the DUI versus STI framework could considerably benefit from referring to the Dewey (1916/1944) and Kolb (1984) traditions when theorizing experiential learning.

Insights and Suggestions Based on Perspectives from Organizational Learning Literature

The literature on organizational learning is vast, but we want to highlight two insights that we find particularly relevant for the issues included in this section: learning how to learn at the organizational level and new perspectives on inter-organizational relations.

One classic in the organizational learning literature is the work of Argyris and Schön (1978), since their theory distinguishes among three types of organizational learning: single-loop, double loop, and third-level, deutero learning. Their tertiary level is akin to that of Bateson (1972) regarding individuals' learning, in that it theorizes the way organizations may learn how to learn through this particular form of deutero learning. However, in recent years, criticism against this framework has pointed out the strong focus on cognitive aspects, suggesting that a pragmatic view that combines cognitive with sociocultural aspects may be fruitful for supplementing the analysis and implementation of learning-to-learn processes within organizations (Elkjaer 2004).

Second, new theorizing takes into account possibly increased complexities when it comes to conceptualizing relationships among organizations, compared to a relatively straightforward way of conceptualizing such relations several decades ago. For example, relations between users and producers may vary as to the role these respective actors have in different contexts, ranging from pure transactions to joint co-development and participation in larger development projects with other organizations.

In terms of concrete suggestions based on the perspectives from the organizational learning literature, our first proposal concerns the learning-to-learn problem. As reviewed, there is heavy emphasis, especially within the Learning Economy stream, on how to achieve learning-to-learn processes. It puzzles us that this stream does not actively use Argyris and Schön's work (1978), for instance. Another avenue when exploring the learning-to-learn problem is for the streams to take inspiration from the pragmatic approach mentioned above (Elkjaer 2004), or to utilize the notion of tertiary level "expansive learning" developed by Engeström (1987). In all the five streams, neither of these is referenced,² and the current notion of learning-to-learn is instead based on references to the literature on the learning organization (Pedler et al. 1991; Senge 1990), a practice we find inappropriate since this body of literature is of a normative rather than of a descriptive-analytical kind (Mumford 1995).

Our second suggestion involves the way inter-organizational relations are treated within the five streams, compared to recent theorizing within the organizational learning literature. We believe that stronger nuance could be added to the notion of interactive learning, as well as the more concrete issues addressed within the Knowledge Bases and Innovation Modes streams, if recent suggestions regarding

² As mentioned earlier, the only exception is the Political Economy stream of Cooke (2007), who cited Argyris and Schön (1978).

useful categories for distinguishing among different kinds of inter-organizational relations were taken into account. Besides the obvious distinctions among private, public, and other types of organizations, the contents of relations may be differentiated into e.g., research and development collaboration, technology alliances, buyer and supplier relationships, and licensing agreements (Meeus and Faber 2006). From the perspective of the organization, it might find itself in simultaneous relations with various partners, and it may make more sense to speak of potential “multiactive” rather than interactive learning relations. Multi-organization “learning networks” established with the explicit purpose of learning may indeed be distinguished from other types of networks (Oliver 2009). However, other network forms may obviously incidentally result in learning as well, but how and why? We propose these issues as one of the topics for future conceptual and empirical research.

Conclusion

In this paper, we have critically analyzed 29 articles pertaining to the NIS and RIS literature spanning the 1985–2012 period by emphasizing learning within innovation processes. We have found it possible and useful to categorize the articles into five streams of literature, due to differences in main assumptions and vocabulary involving issues related to learning. One main finding is that there within all five streams is a significant lack of relating their learning concept to existing theories of learning within educational science and organization theory literature. Rather, the authors tend to operate with indigenous and vague definitions of this concept. This finding amplifies such previous commentaries on the subject.

Another major finding is that it is possible to distinguish among the five streams in terms of the main assumptions about the role of learning. There has been a development from the initial Interactive Learning stream where the concept was used in a general sense, to including the role of tacit knowledge and its conversion into codified knowledge, thus integrating learning processes into a comprehensive methodology in the later streams of Innovation Modes and Knowledge Bases. Furthermore, the Learning Economy stream incorporates the notions of learning and learning-to-learn into the goal of constructing a more general theory of innovation. The Political Economy stream doubts the value of basing its approach on the learning concept and appears to depart from the other streams.

One limitation of our study and with the narrative review genre itself is the literature selection’s semi-systematic basis, with the possibility that literature of some relevance may have been omitted. Taking an interpretative approach in the analytical steps may lead to a degree of subjectivity in assessing and categorizing the works. Furthermore, we have covered only two of several innovation systems sub-fields and are thus unable to generalize the findings to other sub-fields. On the other hand, one major contribution is that our analysis reveals the dynamic development over time within the literature, since it covers a longer time period and a higher number of works, compared to previous commentaries on the subject. The analysis has also distinguished among five streams, whereas previous commentaries tended to treat only selected parts of the literature as a uniform entity.

It may be feasible that methodologies for studying innovation, such as those proposed in the Innovation Modes and Knowledge Bases streams, as well as general theories on innovation, such as that developing within the Learning Economy stream, may function in isolation without considering or incorporating the meaning of the learning concept in other disciplines. However, we are convinced that the future efforts of the mentioned streams could be strengthened by being based on or at least relate their hitherto indigenous learning concepts to pre-existing ones; therefore, we have offered a series of suggestions with reference to theories in educational science and organization literature, respectively.

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