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# Knowledge interaction towards inclusive learning: Promoting systems of innovation and competence building

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**Abstract**

This paper draws on recent conceptual approaches to economic growth, in which the accumulation of knowledge is the fundamental driving force behind growth. This fact is reflected in the trend in developed economies towards an increasing investment in advanced technology, R&D, education, and culture. Concepts such as learning ability, creativity, and sustained flexibility gain greater importance as guiding principles for the conduct of individuals, institutions, nations, and regions. It is thus legitimate to question the traditional way of viewing the role that contemporary institutions play in the process of economic development and to argue for the need to promote *systems of innovation and competence building* based on learning and knowledge networks. This broad concept has motivated the work behind the present work, which reviews the strongest themes of the 4th International Conference on Technology Policy and Innovation (ICTPI), which was held in Curitiba, Paraná, Brazil, in August of 2000. Under the broad designation of "learning and knowledge networks," the conference brought together a range of experts to discuss *technology*, *policy*, and *management* in a context much influenced by a *dynamics of change* and a necessary *balance between the creation and diffusion* of knowledge. While the idea of inclusive development developed in previous conferences entails a process of shared prosperity across the globe following *local* specific conditions, it is crucial to understand the dynamics of the process of knowledge accumulation, which drives a learning society. Thus, this special issue includes a set of extended contributions to the Curitiba conference that are largely grounded on empirical experiences of different regional and national contexts. The aim of this introductory paper is to set the stage for these contributions, with an original contribution on possible views for the learning society. © 2002 Published by Elsevier Science Inc.

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## 1. Framing the conceptual understanding of *knowledge*

Many contributions in recent years have confirmed the perception that the creation and dissemination of knowledge are fundamental factors for the promotion of economic growth, although the scarcity of empirical data on intangible economic factors makes it extremely difficult to demonstrate the growing importance of knowledge. In fact, economic growth has traditionally been explained as being the result of increases in the labor and capital factors and technological change. However, in the light of recent empirical analysis, it is necessary to rethink how these three factors influence the process of economic development.

With regard to the contribution of the labor factor, the facts show that a quantitative increase in population is not sufficient, since developed economies produce ever more intangible factors, creating employment mainly in the service sector, in which educational and professional qualifications are required. It is thus essential for growth and job creation to develop human capital, providing access to more and better skills, particularly through education.

With regard to the contribution of capital, it can be seen that the accumulation of intangible assets is gaining in relative importance compared to physical capital. The importance of knowledge is accordingly seen not only in its contribution to technological change, a fact that has led to a rethinking of traditional ways of explaining growth. The new economic growth theories, which are not analyzed here, bring together many of these ideas, putting forward the message that the accumulation of knowledge, which we will identify with learning, is the most important factor in explaining economic development.

Our inspiration to frame the process of knowledge accumulation comes from the contribution of Lundvall and Johnson [1], who challenge the commonplace by introducing the simple, but powerful, idea of *learning*. Lundvall and Johnson suggest that a ''learning economy,'' rather than a ''knowledge economy,'' describes better the way in which knowledge contributes to development. The fundamental difference between the two expressions is associated with the fact that the former considers a dynamic perspective. According to Lundvall and Johnson, some types of knowledge do indeed become more important, but there is also knowledge that becomes *less* important. There is both knowledge creation and knowledge destruction. By forcing us to look at the process, rather than at the mere accumulation of knowledge, Lundvall and Johnson add a dimension that makes the discussion more complex and more uncertain, but also more interesting and intellectually fertile. The richness associated with the concept of the learning economy is further demonstrated in the volume edited by Archibugi and Lundvall [2].

We attempt to extend the concern associated with the process and with its dynamic character even further. Thus, the title of the paper is ''. . .towards inclusive learning'' entailing a dependence on enhancing the processes of producing and exchanging knowledge and information. This enhancement relies on the build-up of learning and knowledge networks, which must follow *local* specific conditions to adapt, engage, and mobilize local actors and agents. The papers that follow in this special issue discuss critical aspects associated with the process of building such networks, emphasizing the role of social capital and the related business services and infrastructures. In this introductory paper, we will focus on two crucial

elements of "inclusive learning" for development: innovation, on the one hand, and competence building, on the other.

Innovation is the key process that characterizes a knowledge economy understood from a dynamic perspective. Lundvall and Johnson's learning economy is about new knowledge replacing old knowledge. This dynamics is very close to Schumpeter's concept of "creative destruction," which is a standard description of the innovation process. Innovation is associated with creativity, with the generation of new ideas, but also with initiative and risk taking. Innovation entails bringing new ideas to fruition in the marketplace, satisfying demands, or creating new needs, in a process that improves overall welfare.

Competence is the foundation from which innovation emerges and which allows many innovations to be enjoyed. In other words, it contributes both to the "generation" of innovations (on the supply side of the knowledge economy) and to the "utilization" of innovations (on the consumption side of the knowledge economy). Competence is also fuelled by innovation itself. Competence is associated with skills and capacities, both individual and collective. When we consider competence, we focus on a "higher order of skills" [3]. These generic skills include higher levels of education (who can ever be against more education?), but also capacities that are more generic, such as creativity, risk taking, and initiative.

By choosing the themes of innovation and competence building as drivers towards "inclusive learning," we are not considering that these are the exclusive elements. There are clearly other issues of major importance, namely those associated with macroeconomic conditions, but we do not intend to be comprehensive. Our aim is to look for insights through the contributions collected in this special issue.

This introductory paper has six sections. Following this introduction, we conceptualize, in Section 2, "learning." In Sections 3 and 4, respectively, we tackle the concepts of innovation and of competence building. Section 5 introduces the contributions to this special issue and Section 6 provides a brief conclusion.

## 2. Learning as knowledge accumulation: a conceptual framework

The paragraphs above show that, from our perspective, *learning* is understood, broadly, as *knowledge accumulation*. There are different levels of "learning entities," from individuals, to organizations, to whole economies. A first important step in our discussion is the clarification of our conceptual understanding of terms such as "knowledge" and "learning," often loosely used with dramatically different meanings. The recent paper by Johnson et al. [4], following the work of Cowan et al. [5], provides further evidence for the need to clarify these concepts. This conceptual clarification of our understanding of learning as knowledge accumulation is the objective of this section.

We find it useful, as developed in more detail in Ref. [3], to follow Nelson and Romer's [6] differentiation between ideas and skills or software and wetware, to use these authors' nomenclature. The conceptual difference between *software* and *wetware* lies in the level of codification. While ideas correspond to knowledge that can be articulated in words, symbols,

or other means of expression, skills cannot be formalized, but always remain in tacit form. Under this taxonomy, knowledge may be divided into two worlds [4]: the world of codified ideas (software) and the world of noncodified skills (*wetware*).

The difference in the level of codification has implications in terms of the "economic properties" of the two types of knowledge that we consider. The most important implication is associated with the differences in the rivalry associated with the consumption of each type of knowledge. Since the knowledge underlying *software* is codified, it is easily articulated and reproduced by simple, inexpensive means. Consequently, rivalry in the consumption of software is low. By contrast, the transmission of skills (*wetware*) is complex, expensive, and slow. Skills result from a combination of factors, ranging from their largely innate quality, through individual experience, to formal training. Thus, rivalry is comparatively higher in the consumption of wetware.

The differences in rivalry between *software* and *wetware* have important implications for knowledge production. Dasgupta and David [7] suggest that there are basically two alternatives for the production of software. The first consists of *intervention by the state* in the production of ideas, by means of direct production, or by subsidizing production, such as funding of university R&D. The second alternative consists of granting property rights for the creation of ideas, that is by defining regulations for *intellectual property* specific instruments that include patents, registered trademarks, and copyright (see Refs. [8,9], for a more comprehensive analysis). Therefore, the production of ideas requires more complex institutional mechanisms than those provided by the market. As for skills, the market provides a large proportion of the incentives needed for their production, at least when these are analyzed in isolation, although with important limitations (see again Ref. [8]).

We bring our own understanding to the process of knowledge accumulation when the interaction between software and wetware is explored. The idea of *interaction* between ideas (software) and skills (wetware) is what, in our understanding, defines learning. Analysis of the interaction between ideas and skills leads us to explore the learning processes associated with the generation of each type of knowledge in a more integrated and dynamic way, beyond the mere accumulation of ideas and skills, each in isolation. Our view is yet another perspective on the ongoing debate between the complex and multifaceted interaction between different types of knowledge. Recent manifestations of this debate include Johnson et al. [4], in which they contest the implicit assumption of Cowan et al. [5] that codification always represents progress.

Indeed, according to Freeman and Soete [10], ideas and skills are no more than two sides of the same coin, two essential aspects of the accumulation of knowledge. New ideas spur the development of the skills required to use those new ideas. The bridge from the production of ideas to the usage of ideas is established by producing new skills. Increased use of an idea, which requires its diffusion, will lead to a constellation of other ideas, aimed at improving and extending the initial idea, which will lead to the need for further skills and so on, in a self-reinforcing cycle that leads to the accumulation of knowledge. The accumulation of knowledge results from the production, usage, and diffusion of both software and wetware, in an interactive learning process that leads to knowledge accumulation, as initially proposed by Conceição and Heitor [3]. The close and complex interdependence between ideas and

skills that lead to overall knowledge accumulation depends on two types of learning processes. First, learning by codifying [11], associated with the production of ideas, through the codification of knowledge. Second, learning by interpreting [12], related with the production of skills, through the usage, or more broadly, the interpretation of ideas.

Conceição and Heitor [3] show how this conceptual understanding can be used to analyze broad historical interactions between knowledge and development (such as in the evolution of China and Europe [13]) as well as the adoption and diffusion of specific technological innovations (such as standards of videotape recorders). The model also acknowledges the indivisibility of ideas [14] (once created, an idea remains at least potentially accessible everywhere, and there is no need to rediscover it).

This conceptual understanding of the learning processes can also be used to draw implications in terms of the complex relations associated with the building up of innovation systems [15], again as proposed by Conceição and Heitor [3,8]. In this introductory paper, we develop, next, the importance of stimulating innovation (generation of ideas) and, in Section 4, the parallel importance of developing competencies.

## 3. The importance of stimulating innovation

The section above made explicit the way in which we understand learning as knowledge accumulation, which is a result of a complex set of learning processes where there is considerable interdependence between the accumulation of ideas and of skills. We now turn for the analysis of innovation as the concept that best fits with the idea of the knowledge economy understood from a dynamic perspective.

It is by now well understood that the early conceptualizations of innovation as a linear process were clearly insufficient to describe the complexity and contingency of the innovative effort of people, firms, and countries [16–19]. Still, what is surprising is the extent to which the linear perspective still informs much of today's public perceptions about innovation, as well as policy design and implementation. The reliance on simple and direct indicators such as expenditure of R&D by the private sector, and the obsession in some circles associated with improving these types of indicators, reflects the dominance of the linear perspective.

We do not question the importance of these and other indicators, but it should have also become clear by now that they provide an incomplete description of the innovation process and are tied to the linear perspective (see, for the continuation of the linear perspective, Guellec and Pottelsberghe [20]). Romer [21,22] recognizes the importance of what he calls *appreciative theories* of growth and innovation in helping more formal approaches to better describe the richness of the innovation process, but somehow the link has been hard to accomplish.

The link between the complexity of the innovation process and the special economic characteristics of knowledge and of conceptualizations of the learning process such as the one advanced in Section 2 could be a bridge. In fact, Romer [22] and Nelson and Romer [23] constructs his theory of endogenous growth drawing on the nonrival nature of ideas. Dasgupta and David [7] advance new ideas about the economics of science building also on

the same principles associated with the special characteristics of knowledge. Thus, the conceptual understanding of learning advanced in Section 2 could serve more than just being an interesting modelling tool, allowing the development of new conceptual approaches. It could also become a useful guide for policy, especially in light of the still predominant domination of the linear model. In a series of papers, Conceição and Heitor [8] and Conceição et al. [9] have explored the implications of the conceptual model presented in Section 2 to advance policies associated with innovation (that is, the generation of ideas, or software). We turn, next, to the other side of our conceptual model of learning: the importance of wetware.

## 4. The relevance of competence building

Competence is the foundation on which innovation is generated and diffused. Competence is associated with individual skills, but also with collective capacities. It is also on competence that a learning society can be constructed and sustained. Some suggest that technological change is (or has become) skill-biased [24]. Empirical work supporting the skill-biased technological change conjecture includes studies such as Krueger [25]. Thus, for some, the connection between innovation and competences is primarily understood as being related with this hypothesis.

However, the skill-biased technological change hypothesis is far from being uncontroversial. From a conceptual point of view, critics note that the treatment of technological change rarely goes beyond asserting that new technologies, and especially computers, are responsible for a steady increase in the demand for skills. Technology is conceptualized as in the linear models of innovation. Criticisms based on empirical analysis include DiNardo and Pishke [26] and the realization that there is a mismatch in the timing of the increase in inequality and the spread in the diffusion of computers, and the fact that the increased adoption of information technology has not noticeably contributed to increased productivity (Ref. [27] has a comprehensive review). Alternatives to the skill-biased technological change include the perspective advanced by Bresnahan [28], who proposes an organizational complementarity between information technologies and telecommunications (ICTs) and highly skilled workers.

But the relationship between competences and innovation is not only seen through the skill-biased technological change perspective. And competence building also entails much more than formal skills. For example, Dore [29] differentiates "education" from "schooling," which refers to "mere qualification-earning," leading to an "educational inflation" spiral. Several other authors [30–33], are similarly skeptical about a direct relationship between increases in the level of education and economic performance. The differences between the economists of human capital and these other authors, who come primarily from sociology, remain until today. In fact, some of the critiques have important parallels with economic perspectives, such as Boudieu and Passeron's theory of the social filter, whereby schools work as filters to preserve and maintain social and educational differences and the "inheritance of inequality" perspective of Meade [34].

However, if one is ready to accept the existence of a labor market where wages reward, at least partially, productivity and skill, Katz and Murphy [35] provide strong evidence that supply and demand go a long way in explaining the patterns in the evolution of inequality. Most of the recent studies on inequality focus on a single-country longitudinal analysis of the evolution of the dispersion of income. Examples of the same methodology applied to other single country studies include Schmitt [36] for the UK and Edin and Holmlund [37] for Sweden.

This discussion clearly highlights the link between competence (skills, education), and innovation (technological change) towards inclusive learning. The connection among education, skills, and competence, on the one hand, and the learning society, on the other, must consider the manifold interconnections between competence and the learning society and links them with the broader context of the anxieties and concerns, hopes, and expectations that we live with today.

An important issue is to know what it takes to be part of the learning society. We may not know exactly what the learning society is, but we do know that there are requirements to be part of it. We need, in particular, to build competence, of which skills is a part. However, for some cases, the need for new skills is not associated with technological change, but with an organizational change, and the new skills provided are not particularly intensive in specialized knowledge. It is important to stress this point because the discussion can easily be drawn into the skill-biased technological change discussion. Naturally, technological change does indeed play a role in increasing the demand for "a higher order of skills," but there are other elements of change driving this demand. What is hardly questionable is that those that do not possess the skills nor the ability or possibility to acquire them become excluded.

## 5. Introducing this special issue

The analysis above shows that it is thus legitimate to question the traditional way of viewing the role that contemporary institutions play in the process of economic development and to argue for the need to promote *systems of innovation and competence building* based on learning and knowledge networks. This broad concept has motivated this special issue, which integrates a set of new contributions addressing complementary aspects of relevance towards improved understanding of the learning society.

Viotti analyzes learning systems making use of evidence from late industrializing economies and aims at analyzing technology–knowledge networks, namely issues associated with management control. The author attempts to develop general principles for control, oriented towards the achievement of greater efficiency in the management of knowledge in networks. The analysis integrates insights from many and varied fields of research, bringing together different approaches to the issue of management and control of networks. Based on this review, several case studies are analyzed with a mixture of qualitative and quantitative techniques, which provide for a rich description of the empirical material.

Landry, Amara, and Lamari discuss the extent to which social capital determine innovation in manufacturing firms. The authors emphasize the dominating view of the literature on social capital and innovation that claims that social capital cannot be captured through a single indicator, but that it actually takes many different forms that must be accounted for. The results of the paper confirm that the internal creation of knowledge by firms, such as measured by the ratio of sales dedicated to R&D, and the utilization of knowledge embodied in advanced technologies, explain both the decision to innovate and the decision to make more or less radical innovations. However, against all expectations, the authors supply evidences indicating that diverse forms of social capital contribute to a larger extent to explain both the decision to innovate or not and the decision to undertake more or less radical innovations. These results suggest that the policy makers involved in the design of policy measures likely to foster innovation should pay attention to diverse forms of social capital, especially to relational assets and to research network assets as well as to the acquisition and utilization of advanced technologies by manufacturing firms. These results suggest that the efficient governance of innovation cannot be reduced to devising incentives regarding R&D but that it must also rest on incentives appropriate to increase the social infrastructure in which the firms are embedded.

Fernandez de Arroyable and Peña discuss principles for the design and management of knowledge networks, demonstrating the importance of the control function in the management of these complex systems, which may be affected by conflict of interest among parties. The authors conclude that there are two mechanisms for controlling the conflict of interests in the network, namely an external mechanism that depends on the creation of a certain form of organizational structuring, and an internal mechanism based on the development of attitudes and values of commitment and trust.

The three papers described above focus on intangible aspects associated with knowledge networks, as drivers of the learning society. On the other hand, the two remaining papers discuss, respectively, a business perspective for effectiveness of emerging services in the network society and the need for devising new infrastructures.

Oliveira and Roth present a model to describe the challenges and opportunities associated with e-services. The authors construct a well-argued thesis associated with the determinants of success in moving towards e-business and argue that rather than physical infrastructure, intangible assets and core competencies are more important. They propose a model that links the company's choices on knowledge, technology leadership, and market acuity with their competitive capabilities. Agility is also an important determinant of success, but the authors argue that an adequate level of human and social capital is critical for business performance in the network society.

Ferreira, Cossa, and McNigth discuss a solid cost model for next-generation optical networks, arguing that the evolution of broadband services will depend on the widespread deployment of optical networks. The deployment of such networks will, in turn, help drive increased demand for additional capacity. Both new standards and possibly new policy and regulatory or self-regulatory initiatives will be required for the widespread adoption and diffusion of end-to-end optical technologies for high-speed and high data rate services. Incentives for such standards and policy frameworks will come from the benefits of

wavelength markets, or more broadly, bandwidth markets, for consumers and producers of bandwidth-intensive services.

## 6. Closure

We described a conceptual understanding of the relationship between *learning* and *knowledge accumulation*, leading to *economic prosperity*. Our analysis led us to suggest that while the role of institutions needs to be reexamined, the variety of demands and the continuously changing social and economic environment is calling for *diversified systems* able to cope with the need to produce policies that nurture and enhance the learning society.

In addition to the various arguments used in this paper derived from emerging concepts associated with the economics of knowledge, the various papers in this special issue illustrate the importance of demand conditions to allow for technological diffusion in the network society. It is through the diffusion process that technological innovations are translated into wide economic impact, as more and more people and firms consume and use the new products or processes. And if we accept that this increasingly generalized usage of technological innovations fuels, not only increases in well being, but also the conditions to generate further innovations, one cannot escape the importance of demand conditions for economic and technological prosperity in the emerging learning society.

In fact, historians of economic evolution have shown that demand conditions were crucial in the process of early industrialization in the US. For example, Rosenberg [38] describes the demand conditions that were conducive to the earliest stages of industrialization in the 19th century. In fact, in Rosenberg's argument, they were crucial to create a new industrial system out of an agricultural society. An important component of the demand conditions was a relatively high level of income per capita and, equally crucial, a relatively egalitarian distribution of the marginal income available beyond the one needed for subsistence. Inspired by this analysis of the interaction between inequality and technology, we believe the concept of *system of innovation and competence building* discussed in this paper should be further analyzed to improve understanding whether, with the current wave of technological innovations, there is also a relationship between levels of inequality and the rates of diffusion of technology. The argument we are advancing here is that social cohesion, beyond the issues associated with ethical judgement and justice, may also be of importance to the learning society.

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