

An Analysis of Educational Patents of Innovation for Formal Education

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Abstract

This paper analyses business-driven innovation in education by looking at education-related patents. It first draws a picture of the challenges for innovation in the formal education sector, which suffers from poor knowledge ecology: science is hardly linked to core teaching and administrative practices. It then turns to a common indicator of innovation: patents. In the case of education, patents typically cover educational tools. An analysis of education-related patents over the past 20 years shows a clear rise in the production of highly innovative educational technologies by businesses, typically building on advances in information and communication technology. While this increase in educational innovations may present new opportunities for the formal education sector, the emerging tool industry currently targets the non formal education rather than the formal education system. We shortly discuss why business entrepreneurs may be less interested in the market of formal education.

Keywords: innovation, education related patents, technologies by businesses.

1. Introduction

Educational innovation is the act of creating and then diffusing new educational tools, as well as new instructional practices, organizations and technologies [1]. Innovation is not research. It is (often) based on research and the advance of knowledge and consists in changing processes and practices in order to improve the quality and productivity of the service which is delivered [2,3].

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The source of these changes is not innovation but reform! A reform (or “outside in”) logic creates little chance for a successful adoption, implementation and institutionalization of new practices [4,5]. And policy makers will be frustrated by the failure of many reforms to endure and to displace poor practices [6,7]. Instead, innovation involves a decentralized way to use new knowledge and information (both from research and current practices) in order to identify problems and generate solutions [8,9]. Because people are motivated to disseminate knowledge and solutions that they have themselves created, there are natural, but under-used, channels for easy dissemination [10,13]. Last but not least, it is useful to stress that one of the major challenges associated with the study of educational innovation is the lack of data. Studies of technological innovations traditionally focus on research and development (R&D) spending and patenting [7,15].

1.1 A difficult science and a poor link to practices

The educational sector is often characterized by experts as a sector suffering from an innovation deficit and a structural inability to advance instructional technologies and practical knowledge and knowhow about pedagogy at the same rate as what is occurring in some other sectors [11,12]. This problem of a very weak link between science and the improvement of practices is crucial since it influences negatively both the supply of and the demand for research [13,14]. This weak supply and an insufficient demand create a fundamental inertia in the system. Finally, there is a general deficiency of incentives to codify technical knowledge and know-how and the resources allocated to codification are weak. Numerous practices remain tacit; not explicated and not articulated, invisible and difficult to transfer [16,17,19]. “*There is no more in education than a weak equivalent in the field of pedagogical knowledge to the systematic recording and widespread use of cases found in surgery or law and the physical models in engineering and architectural practice. Such records coupled with comments and critiques of experts allow new generations to pick up where earlier ones left off*” [9].

1.2 Translating increasing pressures about performance into innovation

The problem is not so much about the lack of incentives for schools and managers to improve educational practices and technologies; these incentives are there, probably less powerful than in other sectors, but pressure for performance of schools, which are channeled through higher standards and accountability, is increasing and creates thereby such incentives [17]. The problem rather lies in the way practitioners, teachers and administrators try to respond to these incentives and pressure [18]. The problem lies in the failure to translate such pressures into innovation, improved practices and the development of instructional know-how and technologies. Practitioners do not try to improve practices by relying on a strong technical core of knowledge that should be available in case books and data bases. Instead, they respond to the increased accountability by changing structures; but changing structure does not change practices [19,20].

2. Patents in educational and instructional technologies

2.1 *A small (innovation) explosion?*

Educational or demonstration appliances; appliances for teaching, or communicating with, the blind, deaf or mute; models; planet aria; globes; maps; diagrams”. This subclass covers simulators regarded as teaching or training devices, which is the case if they give perceptible sensations having a likeness to the sensations a student would experience in reality in response to actions taken by him; models of buildings, installations, or the like. But it does not includes simulators which merely demonstrate or illustrate the function of an apparatus or of a system by means involving computing, and therefore cannot be regarded as teaching or training devices; components of simulators, if identical with real devices or machines.

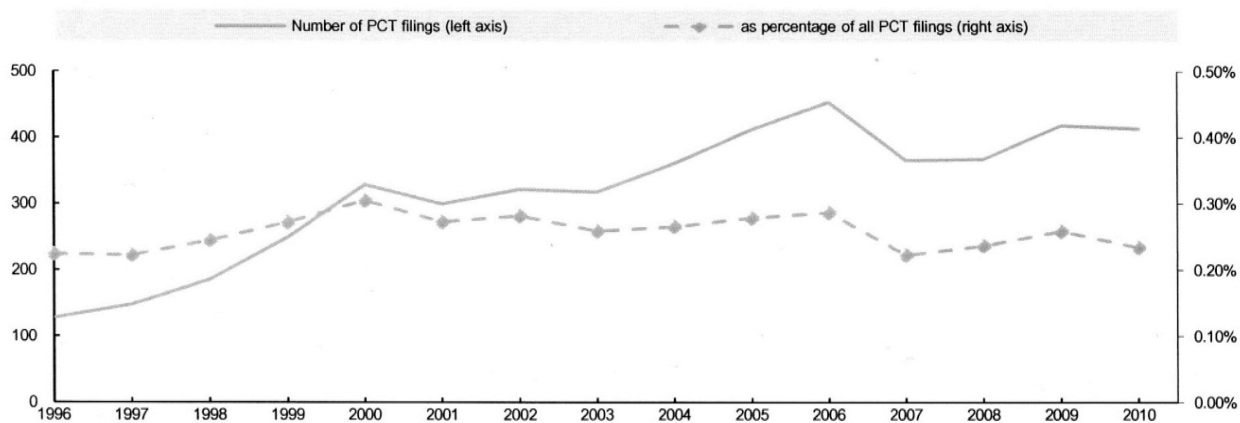


Figure 1. Evolution of world's education-related patents by priority year (1996-2010)

Note: The figure shows the evolution of the number of patents filed in G09B and the evolution of the share of these patents in all PCT filings.
 Source: Based on WIPO Statistics Database

2.2 Examples of education-related patents

Education-related patents are typically filed for products or devices that will be used in a training or education context, for training processes related to a specific set of skills (music, medical, foreign language, reading, etc.), or for a general method that can be used in multiple educational settings. While many patents typically build on advances in information and communication technology (ICT) and propose some sort of simulators of real life practice, patents filed also concern objects or devices or tools that are not primarily ICT-based: card games to learn languages; mock-ups of chests, infant torsos, jaws, blood vessels or organs designed to practice specific medical techniques; teaching devices for some specific mathematical question, for example a device about Pythagoras' theorem demonstrating it arithmetically, geometrically and algebraically; or just a ruler to facilitate the learning of reading.

A list of examples of titles of education-related patents filed in 2010 is provided below for illustration purposes

- Apparatus and method for the lifelong study of words in a foreign language
- Second language pronunciation and spelling
- Foreign language learning device
- Pronunciation evaluating device and method
- Chinese character study book
- Method for learning vocabulary and the principles of English sentences through a card game
- Brass instrument practice device
- Music tablature player
- Portable practice tool for heart massaging in cardiopulmonary resuscitation

- Real-time x-ray vision for healthcare simulation
- Hemorrhage control simulator
- Tracheal intubation training model and method for producing tracheal intubation training model
- Device for simulating cardio-pulmonary resuscitation techniques
- Learning assembly and infant torso simulator for learning the act of respiratory kinesitherapy
- Method for training specialists in the field of ultrasound and/or x-ray diagnostics
- Periodontal training
- Teaching aid for preschool education• Head model for brain-imaging device and technique for producing same
- Blood vessel model for medical training and method for manufacturing same
- Movable learning gaming machine using movable toy
- Weakness finding system and method
- Methods and systems for assessing psychological characteristics
- Method and system for quantifying technical skill (in surgical task)
- Pythagorean teaching device
- Young children's aid to quick counting
- Educational ruler for facilitating reading
- Communication and skills training using interactive virtual humans
- Multi-user headset teaching apparatus
- Adaptive teaching and learning utilizing smart digital learning objects

This growth is not only explained by large companies' strategic behaviors trying to apply their existing technologies to the education sector, as we can observe also the formation of a population of small firms which are specialized in the development of technological solutions to educational problems and issues. This is apparent by the entrance of new firms (Figure 2.a), but also in the declining (technological) concentration evidenced by different indicators.

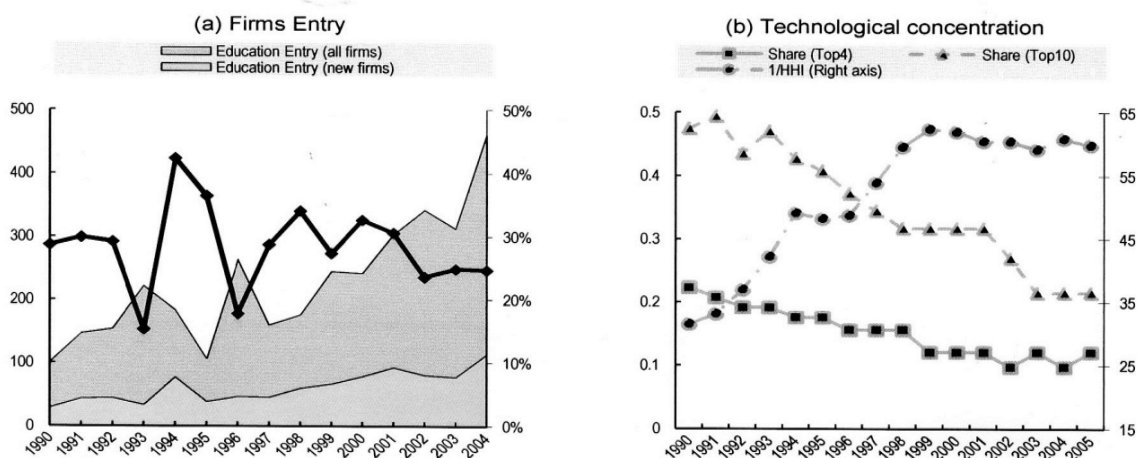


Figure2. Firms filing education-related patents (Entry and Technological concentration)

In any case, these preliminary results suggest the emergence and consolidation of an industry specialized in the production of educational and instructional tools and knowledge with strong roots in new information technologies. A large part of this industry is made of small and specialized firms.

The top 100 firms filing these patent applications are major multimedia and they manage their R&D by harnessing economies of scope, *i.e.* developing educational applications based on their generic technology, as part of a diverse project range. While the major non specialist firms (with fewer than 5% of their patents in that category) are largely predominant for these patent applications, there is evidence that an innovation-intensive industry specializing in education is emerging: there has been a rise in the share of applications filed by specialist firms, owing more particularly to the those filed by Chinese and Japanese firms. The world's share of education-related patents filed by Japan has trebled, and Canada, China, and Korea have also known a significant growth from a much lower starting point (Figure 3)

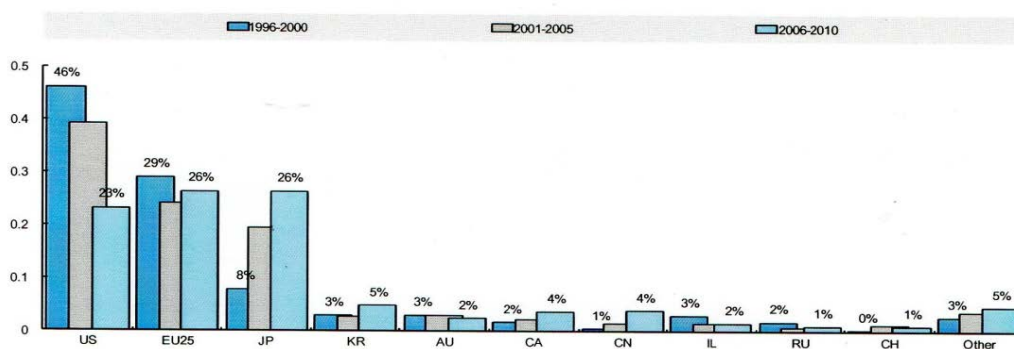


Figure 3. World share of education-related filings by first applicant country

Note: Source: Based on WIPO Statistics Database

The list of the top 100 *specialist* firms (those with 50% of patents in the above category) includes smaller firms: developing and marketing educational solutions is their business model. These specialist firms are mainly Japanese, Chinese and American. As far as geography is concerned, the world share of the United States in education-related PCT filings has decreased significantly in the past 15 years, from 46 to 23%, and is now overtaken by both the European Union and Japan, that had the top education-related number of applications in the world between 2006 and 2010. A small number of countries have increased both number and shares of filings:

Finland, France, Norway, and Spain (while the United Kingdom and the Netherlands have lost some shares). A similar sustained upward trend can also be observed in Korea, China and Canada.

3. The development of technologies defend innovation

Information and communication technology (ICT) is clearly a source of innovation in education systems: ICT offers potentially a wide range of new tools and instruments to profoundly change the technological, organizational and institutional foundations of the sector considered. In this case, the development of ICT provides opportunities to enlarge the repertoire of instructional technologies. The so-called process of co-invention of applications is not a minor matter since it is the process by which the technology diffuses across a wide range of sectors and specific applications are generated. In fact, the characteristics of a general purpose technology (GPT) such as ICT lie in *horizontal propagation* throughout the economy and *complementarily* between invention and application development. Expressed in the economist's jargon, a general purpose technology extends the frontier of invention possibilities for the whole economy, while application development changes the production function of one particular sector.

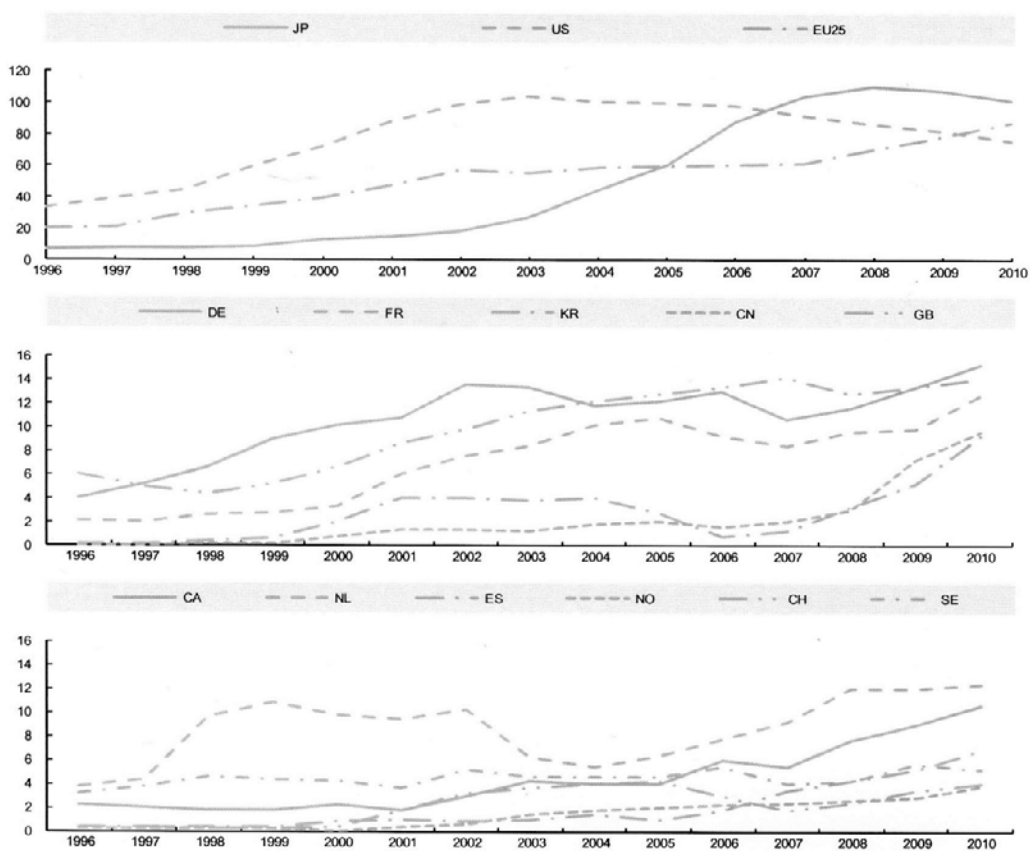


Figure 4. Education-related patent filings by priority year and inventor's country/ Moving average (5 years)

Note: The figure shows the evolution of the number of patents filed in G09B inventor's country.

The basic inventions generate new opportunities for developing applications in particular sectors. Reciprocally, application co-invention increases the size of the general technology market and improves the economic return on invention activities related to it. There are therefore dynamic feedback loops in accordance with which inventions give rise to the co-invention of applications, which in their turn increase the return on subsequent inventions. When things evolve favorably, a long term dynamic develops, consisting of large scale investments in R&D whose social and private marginal rates of return attain high levels.

3.1 A great role in enhancing innovation

A quite intensive innovation activity regarding the development of new instructional tools and technologies is observable. The locus of this activity is not really inside the traditional frontiers of the sector. We observe the formation of a tool industry: a population of specialized firms that invent, design and commercialize educational tools. Such a process, as in any historical case of a tool industry emergence, involves a process of relocation of knowledge – at least in part away from the point of delivery of the educational service. There is some shift in knowledge “holding” which involves the emergence of a new site of knowledge accumulation: the tool producer. Historically, one important reason for the emergence of a tool industry (beyond the classical reason of market size increase) is the rise of a systematic approach to the problem of increasing productivity of industrial or service outputs. The process of relocation of the specialized knowledge about tools outside the institution which delivers the final service (the school in our case) allows to produce generic and multi-purpose machines and tools which replace the specialized tools developed formerly within each specific organization delivering the service. Historically, the formation, emergence and development of tool industries have often generated efficiency gains and economic growth through greater specialization, intra-segment competition between the tool producers and an effective coordination between the tool companies and the downstream organizations. Given our observation and discussion of the innovation deficit in “the core” of the education system (the classroom), it is good news that a population of entrepreneurs enter and grow on the market for new educational tools. Companies competing to invent and commercialize tools are expected to play a great role in enhancing innovation and productivity in the downstream sector. However there is a need to qualify this trend. One important concern is related to the ability of the public sector to exploit the opportunities offered by the emerging tool industry. Another concern is related to the increasing activity of patenting. While the legal monopoly granted by patents is needed for small specialized firms to enter and thrive in the market, it is likely to adversely affect efficiency in the short run (static efficiency) through the pricing of ideas and knowledge which were used to be freely accessible in the former period.

3.2 Patent problems with the new structure

The development of a market for instructional tools can imply that potential users must now pay to access methods and knowledge that used to be obtained for free but are now explicitly priced in the form of licensing agreements. In educational communities, some of the new patents are likely to generate great anxiety as practitioners realize that they are infringing patents and violating the law just by applying methods and practices that they used to apply freely since the beginning of their professional life. Researchers in biomedical sciences are quite good in simply “ignoring” the patents on research tools. And the firms which have been granted these patents either anticipate bad appropriability of their knowledge by granting licenses on a large scale or simply tolerate infractions, especially by academic researchers. This set of norms and practices on both sides result in minimizing in a quite effective way the social inefficiencies which are potentially generated by excessive patenting in biomedical research (the so-called anti-commons problem: see [12]). It is not clear whether schools managers and teachers are in the position to have similar behaviors and what the strategic responses of the small specialized firms holding the patents would be. For example, in 2006 Blackboard Inc. was granted a patent by the US Patents and Trademark Office “for technology used for Internet-based education support system and method” covering 44 different features that make up a learning management system. The problem with Blackboard patents and, we suspect, hundreds of patents for educational technologies clearly involves the now usual conflict between open source communities, which are proliferating in the educational world, and for-profit businesses attempting to enforce their claims on some (software) patents. But a new problem arises here which is about patenting in an area where traditionally the norms of public good and free access were strongly dominant. Another problem with the vertically disintegrated structure of the emerging industry lies in the ability of the small specialized companies to capture the benefits of their innovation. Transaction and bargaining costs on these markets for methods of pedagogy are likely to be very high; and patents as a means to capture the value of the innovation might be not so effective (depending partly about how the first problem is going to be solved). The problems of the firms considered here are rather similar as what has been described by [21] with regard to the tools companies in the biotechnology sector.

4. Discussion

Innovation needs entrepreneurship or at least needs a complex distribution of firm's size and age including a strong population of entrepreneurs at one extreme of the continuum. The author in [1,2] has written extensively and convincingly on the role and crucial position of the entrepreneur or young innovative firms as a mechanism for fuelling innovation and as an organizational form which is needed to complement large companies' modes of operation. But the educational sector seems to have severe barriers to entry so that entrepreneurial activities in the sector sound as not very attractive: the reward structure in this sector is not in favor of competitive entry of new firms and radical innovators willing to take risk and be creative in the prospect for huge private return on R&D and other innovation activities.

5. Editorial Policy

Facing a quite disturbing puzzle:

- The lack of investment in innovation of the education sector;
- The existence, in many countries, of a so-called "big edu" an oligopoly of a few very large
- Suppliers of educational resources which solve the problem of a highly atomized demand by building an enormous sales forces; entrepreneurs cannot afford to play this game;
- Slow sales cycles, as buyers involve too many people "in charge" at different levels (State agencies, districts or local authorities, schools);
- The constraint of pilot programs to test an innovative tool that makes it impossible for startups to sell at a scale that is economically viable;
 - The lack of a business culture for managing innovation in school systems, administrators usually choose the solve problems by using more intensively in house people because this costs nothing (people are already paid for). Few school administrators have a formal training in business decision making or in calculating returns on investment.
 - The treatment of teacher time as sunk cost: people generally see no benefit to saving this time
 - The frequent recommendation by public authorities that administrators should not meet with entrepreneurs and vendors to avoid any unfair advantages, creating a vendor wall that prevents them to be informed about new solutions.
 - The possible interference of foundations and charities that give away for free the very things that entrepreneurs are trying to turn into a business. This unintended consequence of a strategy of building a commons is a well known phenomenon in developing countries, seen as killing entrepreneurial spirit.

All the problems identified above, the public sector of education is also a special market in the sense that "the consumers" do not necessarily want to buy every years a better product that a restless innovative activity need to offer and commercialize.

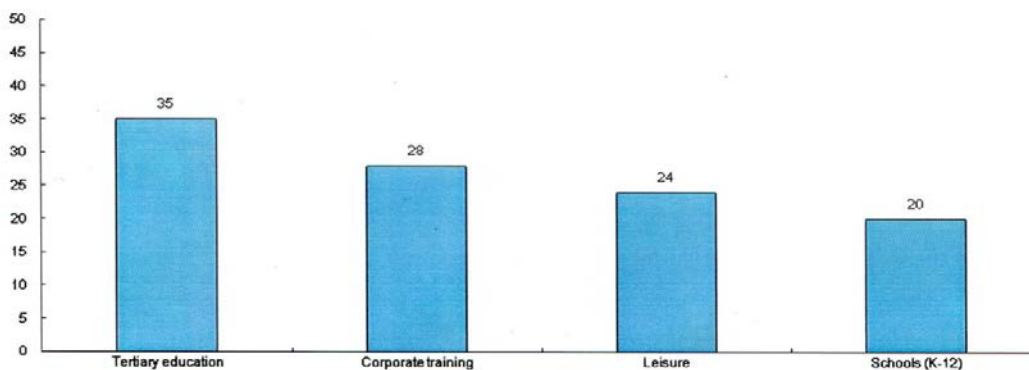


Figure5. Number of top 50 companies with a specialized educational patent portfolio in specific markets (2010)

I observe some intensive innovation activates but the market seems rather difficult: so what are these entrepreneurs really doing? These companies are targeting other markets that the formal primary and secondary education sector: corporate training, education during leisure time and tertiary education are perhaps smaller markets but they seem far more entrepreneur friendly. An in depth analysis of the top 50 specialized companies in patenting educational tools allowed us to identify in which education markets they operate. Figure 5 shows the results of our web search: 35 out of the top 50 specialized firms operate in the tertiary education market, while only 20 operate in the schooling sector. Fewer companies commercialize their inventions in the formal primary and secondary education system than in the other market segments.

6. Conclusion

A good news for education – a sector which displays notorious difficulties to generate and exploit innovations to improve practices – is that an educational tool industry has emerged; that is to say a population of small firms specialized in inventing and commercializing (mainly ICT-based) instruction technologies. New sites of knowledge generation and accumulation have emerged: the tool producers. However the main commercial target of these companies is not the huge public school system. This market does probably not satisfy most conditions for attracting and sustaining a strong entrepreneurial activity in the tool business. Could the public school system better exploit the opportunities offered by the development of a tool industry? Is there enough innovation friendliness in the public sector in terms of management practices, governance and culture, as well as funding and resource allocation logics? These are some of the issues that education decision makers should now start examining. Other “smaller” markets seem to be attractive enough for entrepreneurs and this connection explains to a certain extent why we have observed the patent explosion and some increase in the number of firms specialized in the tool business. An important question for further research is whether the invention of tools for corporate education (or training) and other “smaller” markets” has *spillover* effects in the sense of building user capabilities (in a very broad sense) in the large formal primary and secondary education sector so that this sector can progress in learning how to exploit the opportunities offered by the growing educational tool industry. A conclusion section is usually required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

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