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A Hybrid Space to Support the Regeneration of Competences for Re-indutrialization.
Lessons from a Research-Action

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Since the 1970s, in many European industrialized areas, cities have undergone radical transformations to cope with de-industrialization but also with the new needs of the post Fordistic organization of the factories and their ecosystems: logistics and transport requirements were demanding new functional areas, business services – from individual units up to big service companies – needed different configurations of working spaces, urban sprawling increased to satisfy residential needs. A huge amount of manufacturing buildings has become no longer appropriate for many production processes and the future of the old industrial premises has punctuated the public debate of the past forty years: from their restoring (to keep traces of local socio-technical identity), to their demolition (to provide new appropriate production or living spaces), to their re-use (for hosting new activities). In the somewhat drastic passage from the past industrial era to the future digital economy, medium size cities in industrialized areas present some specific challenges when they have to support the new manufacturing age: not only with new spaces, but also with new skills. In recent years, many public (and also private) initiatives have proposed and implemented the transformation of old manufacturing building in new settings to foster creativity-and-innovation, a condition considered essential, among others, to create new opportunities for growth. Are the re-uses of buildings effective for that goal? Is contamination in hybrid spaces the crucial ingredient for their success in supporting creativity? These questions appear even more critical when we are confronted with the creation of new skills for re-industrialization in areas that are still pillars of manufacturing activities but that are progressively lost the social fabric that reproduced skills. Although their general character is to enable information and communication flows, cities in industrialized areas have lost some important pieces of knowledge on material processes.

In this paper, we address some of those issues by investigating the action-research called “Officina Emilia”, which was initiated in Italy exactly with the goal of regenerating competence networks in a manufacturing area. Officina Emilia devel-

oped some distinctive features: the creation of an original space, Museolaboratorio, designed as a hybrid space; the action-research program to introduce changes through the context-based technology education; the intent to build on a large and qualified network, supporting the innovation in the education system at regional level. These features will be discussed below. The rationale for this analysis is to single out which are the agents, the processes and some conditions that may hamper similar initiatives. In this chapter we first introduce, in section 2, the interdependencies between economic system and education system. We discuss a new approach to technology education in context, and the specific characters of what is needed to improve such context-based education. In section 3, we present the education activities produced by Officina Emilia. In section 4, we comment the lessons learned from the action-research that created a hybrid space. Our focus is on the relevant agents, artefacts and interaction processes that can support social innovation in education to enhance significant learning, to meet the changes of the world of production and to address the complexity of concrete situations. Section 5 concludes with some remarks on the lost and missing links hampering the action-research to become action.

The Interdependencies between Economic System and Education System

A re-industrialization of Europe is becoming an imperative to support a path of sustainable development characterized by social inclusion and innovation, as remarked also by the Report on EU competiveness (European Commission 2013, 2014). The main rationale for strengthening the manufacturing sector in Europe is based on the acknowledgment of its being the place of significant innovation, which in turn also provides opportunities for growth in the service sector as well (in particular business services). Although it constitutes a decreasing share of Europe's GDP, the manufacturing sector is still the engine of modern economies. Because of backward and forward linkages (Hirschman, 1958), the development in manufacturing sector has a multiplier effect on the growth of the economy (Berger, 2013): a general increase in productivity of the manufacturing sector makes a contribution to the growth of GDP that is four times higher than that of other inputs.

There are a large number of common features among the skills required (in quantitative and qualitative terms) to support changes in technology and organizational models, either in the companies, in the institutions and in urban spaces. New skills can be nurtured in workplaces and they are needed by the labour force already employed (or seeking employment). But there is strong evidence that it is more effec-

tive to incorporate the development of new skills already in the educational pathway (particularly in the upper secondary level and in the university). Both the companies and all the adult education and training organizations should be better integrated with the general education system.

With regard to Italy, the capacity of the actual education system to create and develop adequate skills does not meet current needs. The international comparisons clearly show that Italian students have lower scores in the standardized tests and a longer school to work transition (OECD, 2014). Moreover, there are substantial differences in performance across the national territory and many concerns arise from the bad results of the immigrant students and of the vocational education and training schools. A similar situation was observed in other European education systems, and this is why in the last ten years the European Commission has pushed on innovation in education toward new skills for new jobs (European Commission, 2008).

New skills are required not generically in STEM, but specifically in understanding the functioning of complex systems, in operating in environments with ill-structured problems and in transferring knowledge and skills in different situations from those in which they were acquired. These capacities are suitable to support the regeneration of the manufacturing sector and to improve the social innovation, but they are very different from those described in the labour studies (Braverman, 1974) and in the classical management theories (Fayol, 1949). Those skills are focused on the technologies and the organization of work according to a Tayloristic and Fordistic production model. In Western countries, because of broad sectoral, institutional and technological changes, rooted in the crises of the 1970s, jobs in many manufacturing industries are no longer broken down into routines and well-defined tasks, with the implication that workers can no longer focus only on a particular subset of tasks and consequently, written rules and procedures are less effective in facilitating coordination and ensuring uniformity. Lastly, work specialisation is no longer the only element producing efficient performance both in technical and managerial functions.

Skills to be promoted in the education system must address not only employability, but also social cohesion, inclusion and active citizenship (European Commission, 2012). The inability of young people to understand the context in which they live may be one of the reasons why social cohesion of several local communities is too often threatened (Cresson, 2003). A considerable amount of evidence leads to believe that these skills are dramatically poor among too many young people (Thomas, 2003).

If new skills and knowledge have to foster innovation and creativity, then the curriculum (i) must cope with the realm of technology and (ii) must build countless connections across economics, sociology and the studies of institutions. Moreover, new curricula must find ways to enhance the capacity to understand the social, economic, historical and cultural heritage, and the concreteness of the actual conditions of life and work. New contents have to be introduced and teachers have to be trained to cope with more subjects, in order to be able to design and manage multidisciplinary teaching-learning actions.

The vocational courses, at secondary, post-secondary and tertiary level, have to be re-designed to cope with the new training needs of mid-level technicians, especially those employed in industrial sectors, and in the mechanical industry in particular, not forgetting for new managerial and marketing skills. The skills of workers in the industry are less and less linked to specific tasks and duties. Conversely, they greatly need to connect the capacity of each professional position with the processes as a whole and with the company's mission and goals.

The demand for new skills pushes the entire education system on several related interventions: to reduce the early school leavers, to support lifelong learning of the adults, to reduce various types of cognitive barriers, to introduce new learning processes. In this section we shall focus on the latter, on which we suggest to ground all the other related interventions. The most important and significant contributions in designing new learning processes derive from Vygotsky (1934, 1978), Dewey (1897, 1915, 1938), Piaget (1974), Bruner (2009), Papert (1993) and Hutchins (1995) who focus on contextualized knowledge, the opening of the learning environments and the cooperative ways of learning and working. During the Eighties and Nineties, in the US and, until now to a limited extent, in Italy and in Europe, some efficient teaching methods have been tested, compared and evaluated to help students to improve their diagnostic skills, when working on "ill-structured problems". Labelled as "problem-based learning", a group of different teaching-learning practices has been described in a structured way (Barrows, 1985, 1986, 1992). This method is greatly considered as a suitable model for training teachers and for being a standard to be promoted in schools. The need to design effective educational activities for new skills finds in the studies of Papert other valuable suggestions. Following a long experimental process started in 2000, in the 2009 the Exploratorium of San Francisco (CA. USA) presented to the general public a prototyping new space called the "Tinkering Studio" (Petrich *et al.*, 2013). These experiences are now documented and supported by an online training free course for teachers. The method introduces hands-on activities and allows teachers to broaden the possibility of a greater number of students to learn effectively very complex topics.

In a companion paper (Mengoli and Russo 2014), we argued that it is necessary to boost innovation in the whole education system, from pre-school to university. In particular, the education system must take on the challenge to provide or to increase the provision of the ability to (1) apply in different environments what has been learned, (2) understand the social, economic, historical and cultural heritage of the context in which people live and work, (3) master knowledge of the core work processes. To reach these goals, the education system should allow students to have experiences in several different environments and to be aware of the concreteness of the material conditions of life and work (Cedefop, 2008; Giarini and Malitza 2003).

Officina Emilia Action-Research

Innovation processes in education must address contents and methodologies, the required structures, resources, materials and competences, as well as institutional settings. It is well known that such innovation processes call for systemic reforms in education. When coming from the centre and spreading in the periphery, they could take a long time to be defined and implemented. In this paper, we argue that, alongside the crucially important national and general reform initiatives in education, there are feasible, faster and incisive changes which must start involving local actors in action-research practices.

An example of such interventions is the one realized through the initiative "Officina Emilia": an action-research supported by the University of Modena and Reggio Emilia that produced meaningful actions with and inside schools, aiming at supporting changes into contents and methods of teaching–learning, linking science, technology, engineering, mathematics and social sciences in a more effective way through the design of relationships, tools, innovative pilot actions (Mengoli and Russo, 2000, 2009).

Officina Emilia sought to support bottom up changes in education through multi-agent and multi-level actions: an open public space was designed to allow students, educators, production and technology experts, policy makers to open their mindset and improve the understanding and practices on the issue of regeneration of competences. Public hybrid spaces are increasingly recognized as loci to foster innovation processes, since they provide a venue in which new ideas and insights can emerge by allowing interactions and interpretative ambiguity. As Lester and Piore have stressed (2004), often, these are the missing dimensions in innovation processes, which are nurtured not only by analysis and problem solving, but also by generative relationships which are based on heterogeneity, aligned and mutual di-

rectedness of the relevant agents, and appropriate permissions to support agents' opportunities of action (Lane, 2011).

Pushed by the results of empirical analysis on the changes in the local manufacturing industry and by international debate (Mengoli and Russo, 1998) on the challenges in supporting the education system, in 2000 the University of Modena and Reggio Emilia (Italy) started the action-research programme Officina Emilia. Built on comparative analyses of education systems, industrial district development and regional policies, Officina Emilia addressed multiple social, economic and technological needs of the region in which the university operates. At that time, the economic debate was strongly influenced by the ICT boom and the manufacturing sector was considered to have lost relevance for economic development, particularly in the more advanced and rich western societies. The Officina Emilia initiative pointed out that not only this sector, and the regional mechanical industry in particular, continued to support the growth of the Italian economy, but that it would cease to do so unless special competences generated and nurtured inside the manufacturing companies were re-generated and supported (Russo, 2015). The action-research was investigating which were the relevant agents to be involved in the competence regeneration and which processes had to be started or strengthened in order to improve the context-based technological education.

Following a period of analysis of the industrial structure of the mechanical industry (Metalnet project[11]; Russo, 2008) and development of projects to outline the action-research (Memo 2001-02[12], Corni80-2001, Rubes 2002-04 and Startup 2005-2006[13]), since 2006, Officina Emilia carried out a coordinated package of educational activities, which included tinkering activities[14] and educational robotics, to be placed in a new and innovative "regional curriculum". The educational activities were realised in collaboration with teachers, schools, training agencies, a significant number of small and medium enterprises (in the engineering sector and

11. "Metalnet" is a research project on the structure and dynamics of the mechanical industry. Documents are available on line at www.metalnet .unimore.it.

12. A video presenting Memo was realized in 2008 by the Italian Ministry of Education to assess the results five years after the end of the project. See https://vimeo.com/55765744.

13. Documents on these projects are available on line at http://www.officinaemilia.unimore.it /site/home/officina-emilia/i-progetti-dal-2000.html.

14. This perspective was embedded in the social practices shared in the pre-primary and primary schools in Emilia-Romagna. A special goal of the action-research was to adapt those practices in secondary school and University.

providing industrial services), as well as the representatives of multinational companies, all the main trade unions and the business associations.

The long experience matured in these activities, carried out within the schools, made clear that: the classrooms were not appropriate to set the hands-on workshops and a virtual space where to share documents on the ongoing practices (as it was since the beginning the official website of the initiative) was not enough to boost and disseminate the expected changes. The need to set up a dedicated physical space to support the action-research found an answer in the proposal of a special Museum-workshop (Museolaboratorio) designed to carry out the activities dedicated to students, the initial and in-service teacher training, and the networking activities at local, regional and national level involving, among many others, companies (particularly SMEs in manufacturing sector) and public administration. The venue of the Museolaboratorio was a factory no longer in use, in the industrial area of the town. It was composed by six main sections: a display of historical machine tools, a tooling workshop[15] with working machines, a true to life video on work in mechanical industries entitled "Places, people, machines and work"[16], the "log book" section[17], the "metrology room"[18] and the "room of the innovations"[19].

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15. In mechanical engineering firms, the tooling workshop is a very important place: for constructing or fine-tuning a prototype, for repairing a component part and, at times, for studying problems and finding practical solutions. In the tooling workshop of OE it was possible to realize hands-on activities with tools and materials to understand properties of different metals and how they are tooled, to observe mechanical parts being made; understand how the tooling machines work; follow some manufacturing processes phase by phase; see how a technical drawing is used to set up and programme a machine. "Safety at work" was embedded in the experience of users as a crucial component of knowing human-machine interaction.

16. http://www.officinaemilia.unimore.it/site/home/officina-emilia/i-progetti-dal-2000/parole-di-lavoro-2008-2009.html.

17. Officina Emilia made tens of visits to mechanical engineering firms in the Modena area. In each visit, a large set of information was collected and many artefacts were donated by the companies: put together, the artefact formed a kind of logbook marked by the motto "Touching is strictly allowed!" (and smell was another experience). Detailed information on the production processes and the producers of those artefacts are available at http://155.185.65.22/oe-imprese/.

18. In mechanical engineering it is essential to carry out checks with the proper measuring instruments. The metrology section allowed using a number of these instruments – both analogue and digital, with various degrees of precision – that have undergone technical changes similar to those that have marked the development of machine tools.

19. The goal was to engage companies, research laboratories, university teams to create their own exhibitions to share meaning on innovation as a technical, social and economic process.

In the design phase, Officina Emilia was open to discuss hypotheses, share methodologies, co-design activities and debate results with academic and practitioner communities in Italy and in international projects[20]. The methodologies adopted to facilitate the diffusion of innovative teaching-learning practices were founded on four pillars: (i) direct educational actions on students to develop innovations to be disseminated and promote change in the way of daily work of the schools; (ii) teachers training with new active practices; (iii) the involvement of the population and the students' families in specific programmes to know the economic, technological and working issues of the fundamental light mechanical industry; (iv) the promotion of a new collective support to the manufacturing development and to the new skills needed by the SMEs.

Focusing on the education activities carried out with teachers and their students, Officina Emilia contrived innovative hands-on activities by using significant artefacts, objects, products, tools and machine tools used in small and medium size engineering companies[21]. The educational activities combined knowledge of production technologies with direct knowledge of life and work experiences of workers and employers, inside their workplaces. Hands-on education activities, using and also producing *ad hoc* educational materials and multi-media contents, were as important as the meeting and the interviews with professionals conducted by students. Guided visits, periods of internship were complemented by activities in the Museolaboratorio and in the school classrooms.

Officina Emilia's tinkering labs for primary school and labs on regional socio-economic history for secondary schools started in 2001, robotics and other tinkering labs for schools of all levels and grade where developed since 2005. The cooperation and the training carried out with teachers, as well as the dynamics of the learning process of the students involved, made it possible to modify and refine the protocols and the materials to be used in the labs. Between 2009 until 2012, the activities realized in the Museolaboratorio premises involved approximately 5,000 students from pre-school to upper secondary education. Nearly 170 teachers have

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20. Over 15 year, more than two hundred people were involved in designing, planning, testing and evaluating the education labs and in design and setting up the museum-laboratory. Most of them were university researchers, school teachers, professionals, staff of the business companies that were partner of the initiative. Over 15 years, the action-research received competitive funds for about 1 million and half euro, from RDF and from local Bank Foundation. A detailed account is available on line.

21. This activity was developed in collaboration with the network of companies partner of Officina Emilia action-research (see Russo, 2016).

been involved in in-service training to promote changes into their everyday work, 12 schools signed a permanent agreement of collaboration on innovative education to be developed with the support of the university, and 3 schools introduced Officina Emilia labs in their official curriculum.

The Officina Emilia educational labs are just one part of the action-research program. Several other initiatives involved adult people were carried out to spread knowledge and awareness among people and the students' families too. These initiatives had always held a large public audience for their originality and because they met several knowledge and skills spread among the population, but without any space in cultural and collective events, despite the social and economic relevance of the highly industrialized areas considered. The Officina Emilia events also enjoyed the novelty derived from the use of little-known at local level new materials such as smart bricks of LEGO Mindstorms® and the electronic card Arduino.

Lessons from the Action-Research

Many lessons emerge from the Officina Emilia action-research and in particular from the Museolaboratorio pilot actions as educational space simulating a working environment of manufacturing sector (light mechanic industry), and as hybrid space that combines educational uses, research and outreach. A selection of those lessons are briefly recalled here.

Competences required a hybrid space like the Museolaboratorio

Groups of researchers from engineering studies, physics, materials chemistry, economics, sociology, communication, pedagogy and didactics were involved in the Officina Emilia action-research program. They were able to create theoretical documents and reports to disseminate experiences and evaluate their results. Beyond the contribution of researchers in different fields, what are the skills needed to design and manage the creation of relevant learning in hybrid spaces? Three professionals are usually involved for their know-how and their experience: the craft-workers, or technicians experienced in traditional methods of production, new makers and teachers of technological subjects in schools and training centres. When these professionals are involved at the same time, their cooperation must not be taken for granted. The differences in experience, career and age count a lot and it is not easy to boost the desired effects. Moreover, time constraints and the rigorous methodologies of the research were often experienced by professionals as im-

positions, hindrance and pitch invasions, and funding a common ground may become challenging.

The design of hybrid spaces generally relies on competences of experts able to transfer practical learning and to design and create products and know-how. The Officina Emilia experience warns in narrowing the discussion only on these professionals. For example, the craft workers and the production technicians (experts in traditional technologies) are able to pass their manual skills through coaching, in a very long time and inside workplaces that no longer exist or that are specific for a particular sector or even a single company. Moreover, present safety standards are not always part of their experience. But, above all, the way they do is no longer supported by the social conditions that created consensus and appreciation for their educational task. Their ability to teach soft skills is too limited, with reference to the communication, collaborative peer relationships, documentation and research needed for a comparison of the technology and the products in situations far in space and in time. Another example is provided by the new "makers". They are still too poorly defined to allow a discussion on their educational effectiveness. How many "makers" are craft-workers, production technicians or traditional craftsmen? How many are *bricoleurs*? How many of them are highly specialized professionals on specific processes, materials and products, with little experience in other workplaces, so with visions and practices too dependent on one specific context? Professional features of the individuals involved are certainly dependent on individual factors, that make their educational contribution rich of variability, but also unpredictable.

Lack of managerial competences strictly devoted to promote the "brand" in the media and policy networks were not overlooked aspects, but missing competences in the area that was impossible to attract (scale matters in attracting those competences!).

Activities of classes in hybrid space

The involvement of schools in activities of the hybrid spaces (such as Fab labs, enterprise workshops or museum workshops) and the introduction of labs with 3D printers inside schools may produce little or not at all significant changes of the quality of learning of the new generations. The simply supply of technologies or making people aware of innovative machines is unlikely to change the actual educational practices. As happened in Italy with the public investment on interactive multimedia whiteboards, interactive projectors and other technological devices (with teachers and schools that still underuse or misuse those devices). Public in-

vestment designed to the Fab lab, especially the commitment to involve schools in their activities, and investments to the spread of other technological tools, have the advantage of focusing attention on the need to connect the information technology with most extensive learning of the production techniques. However, the experiences that schools are carrying out patchy, do not yet found sufficient assessment research. They risk to waste valuable time for the development of an effective strategy to support schools, training centres and enterprises. To develop effective innovations, three main aspects should be fostered: a greater care in the management of change, a better design of both the educational activities and teachers' in-service training, a stronger support to communities and networks of practices.

Creation of ad hoc information in an ad hoc environment

The experience of Officina Emilia shows that hands-on activities, and opportunities to conveniently observe a workplace widen the horizon of thinking, help the imagination, support self-esteem in confronting technological challenges (in particular with regard to girls approaching technologies they consider as largely out of their interest), and open students to new domains (e.g. reconnecting what students do in the labs with their parents' or relatives' jobs, which they generally do not consider of any importance and they learn to appreciate in different perspectives). These processes fail to emerge for spontaneous sprouting inside schools or at least fail to emerge with the quality and the required size. The first and most important reason is that teachers express a strong need for data and tools to effectively introduce their students to the knowledge of the structure of the industrial area in which they live, and which influences their educational, training and professional opportunities.

Fifteen years after: do the critical initial conditions still matter?

At the start of the action-research program, some empirical facts were urging some intervention: the shortage in quantitative and qualitative terms was hampering the growth of SMEs in the mechanical district. What did happen in the following 15 years after?

Until 2008, the high pace of growth of the majority of the regional companies was supported by the growth of international demand: the increase in sales was accompanied by only a marginal increase in employment. Investments in physical capital ensured higher productivity, better quality and the requirements of the international standards. High level competences were shifting across companies, with increasing salaries of high level technicians and managers. Mid-level technicians

were still as scarce as at the beginning of the period, but internal training was allowing SMEs to cope with their needs, at least in the short medium run. Some critical problems were appearing more relevant than in the previous decade: the generational change in the ownership and control of SMEs; the creation of new companies was slowing down, the vertical and horizontal organization of the value chains was largely changed making more acute the need for technical, organizational and managerial skills in a rapidly changing environment (Russo and Whitford, 2009). When in 2009 the crisis affected the mechanical district, its effects were not equally heavy (as discussed in Russo, 2015). Even though the overall effect on employment was significant, opportunities for mid-level and high-level technicians emerged. Not a zero sum game: several SMEs closed and recovery has been accompanied, in many cases, by a radical re-design of production processes; network and power relationships changed greatly across the companies still active in the district. The demand for more qualified workers still remains a challenge: qualitative and to some extent also quantitative.

From Action-Research to Actions: Lost and Missing Links

In recent years, other experiences have developed hybrid spaces. With reference to the Emilia-Romagna region, it is to mention the construction of public funded Fab Labs, in Reggio Emilia and in Modena, and the opening of the private and public partnership supporting Opificio Golinelli in Bologna. Moreover, artefacts to support tinkering labs emerge at the national level, such as the intervention of Federmeccanica on primary schools which is titled "Eureka! It works", which produced an educational kit usable in many different ways.

Why did the University, that in 2000 approved Officina Emilia as one of its relevant projects, decide to close in 2015 to close the Museolaboratorio? Several factors were not favouring a longer lasting of that experience. A positive evaluation plan of the impact of the activities carried on with schools was not enough to support some drawbacks.

First of all, even though the University invested human and material resources for about a decade, also in view of enhancing the quality of learning of incoming students, the absence (or weakness) of its institutional recognition by the authorities in charge of the regional education system, greatly limited the diffusion of the innovative practices produced by Officina Emilia. The initiative was not able to cope with changes in regional policy orientation: at the beginning there was a strong support to exploit innovation potentials in the many related fields in local development, after six years the regional administration was shifting toward a more sec-

toral vision on top down and more controlled intervention from the entrepreneurial side and from the education side. In the last years, the University itself was reducing its strong support: the initiative was outside the primary missions of university: education, research and technology transfer, at that time considered the only relevant activity to support "third mission". Then, when the crisis imposed cutting expenses, there was no longer the financial support for its public engagement, which nowadays is strongly recognized as a crucial component of the university third mission. The economic crisis was an exogenous factor hampering the support from the network of partner companies of Officina Emilia: they cut all supports to any initiative, in a condition of reduction of production, layoff of workers and declining revenues. These processes and conditions highlight that, notwithstanding the many fruitful generative relations both at regional and international level, the lack of some local linkages was marking the initiative as a university lobby: even though it was well known and appreciated for the quality of the innovative proposal carried on by the initiative, the strong branding of Officina Emilia was ignored in the regional media. In a nutshell: missing institutional links have progressively reduced consensus to the action-research, not allowing the progress toward more structural actions. Monitoring of generative relationships is a reflexive perspective on the ongoing processes, but obviously it is not enough to generate the missing links.

References

Barrows, H.S. (1985). *How to design a problem-based curriculum for the preclinical years*. New York: Springer Publishing Co.

Barrows, H.S. (1986). A Taxonomy of Problem Based Learning Methods. Medical Education, 20, 481-486.

Barrows, H.S. (1992). *The Tutorial Process*. Springfield, IL: Southern Illinois University School of Medicine.

Berger, S. (2013). *Making in America. From Innovation to Market*. Mit Press, Cambridge, Mass.

Braverman, H. (1949). Labor and Monopoly Capital, Monthly Review Press, New York.

Brynjolfsson E., Mcafee A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. Norton New York London: W.W. Norton & Company.

Bruner, J. S. (2009). *The process of education*. Harvard University Press.

CEDEFOP (2008). *Skill Needs in Europe. Focus on 2020*. Luxembourg

Cresson, E. (1998). Learning for active citizenship: a significant challenge in building a Europe of knowledge. In: European Commission. Education and Active Citizenship in the European Union, Brussels

Dewey, J. (1897). My Pedagogical Creed. In: The School Journal, Volume LIV, Number 3 (January 16), pages 77-80.

Dewey, J. (1915), The School and Society, The University of Chicago Press, Chicago, Ill.

Dewey, J. (1938). Experience and Education, Kappa Delta Pi, International Honor Society in Education, Indianapolis, IN

European Commission (2008). New Skills for New Jobs. Anticipating and matching labour market and skills needs. Brussels

European Commission (2012). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Rethinking Education: Investing in skills for better socio-economic outcomes, (COM(2012) 669 final, Brussels

European Commission (2013). Directorate-General for Enterprise and Industry (2013). European Competitiveness Report. Towards Knowledge-Driven Reindustrialisation, Commission Staff Working Document SWD(2013)347 final Commission Staff Working Document

European Commission (2014). Directorate-General for Enterprise and Industry. European Competitiveness Report. Helping Firms Grow, Commission Staff Working Document SWD(2014)277 final

Fayol, H. (1949). *General and industrial administration*. NY: Pitman.

Giarini, O., Malitza, M. (2003). *The Double Helix of Learning and Work*. UNESCO, CEPES, Bucharest

Hirschman, A.O. (1958). *The strategy of economic development*. Yale University Press, New Haven

Hutchins, E. (1995), Cognition in the Wild. MIT Press, Cambridge, MA.

Lane, D.A. (2011). Complexity and Innovation Dynamics. In: Cristiano Antonelli, C., (ed.) Handbook of Economic Complexity of Technological Change. pp. 63-80. Edward Elgar, Cheltenham UK

Lester, R., Piore, M. (2004). *Innovation: The Missing Dimension*. Harvard University Press, Cambridge MA

Mengoli, P., Russo, M. (1998). Technical and vocational education and training in Italy: structure and changes at national and regional level. Materiali di discussione n. 255. Dipartimento di Economia Politica. Università di Modena e Reggio Emilia.

Mengoli, P., Russo, M. (2000). Competenze, innovazione e sviluppo locale, Materiali di Discussione 397, Università di Modena e Reggio Emilia

Mengoli, P., Russo, M. (2009). The Officina Emilia Initiative: Innovative Local Actions to Support Education and Training System, Materiali di Discussione 613, Università di Modena e Reggio Emilia

Mengoli, P., Russo, M. (2014), Education with micro-robots and innovation in education (4th International Workshop "Teaching Robotics & Teaching with Robotics", Padova, Italia - July18, 2014, in Dimitris Alimisis, Grzegorz Granosik, Michele Moro, *Proceedings of 4th International Workshop "Teaching Robotics & Teaching with Robotics" & 5th International Conference "Robotics in Education" (2014)*, IT+Robotics srl Vicenza, pp. 152-159

OECD (2014). PISA 2012 Results: What students Know and Can Do. Paris

Papert, S. (1993). *The children's machines: rethinking school in the age of the computer*, Basic Books, New York

Petrich, M., Wilkinson, K., Bevan, B. (2013). It looks like fun, but are they learning? In M. Honey & D. Kanter, (Eds.), Design, make, play: Growing the next generation of STEM innovators (pp. 50-70). New York: Routledge.

Piaget, J. (1974). Dove va l'educazione? Roma, Armando.

Russo, M. (2015). Distretti, piccole imprese e sapere diffuso nei sistemi produttivi della meccanica, in L'Italia e le sue regioni. l'età repubblicana. Territori, a cura di M. Salvati e L. Sciolla, Istituto della Enciclopedia Italiana Roma, volume II, pp. 147-160

Russo, M. (eds.) (2008). *L'industria meccanica in Italia. Analisi spaziale delle specializzazioni produttive 1951-2001*, Carocci, Roma.

Russo, M. (eds.) (2016). Documenting work through videos. A project by Officina Emilia with nine engineering firms in the province of Modena (2008-2010) with S. Pozzoli and F. Tantillo, DEMB Working Paper Series 93, http://merlino.unimo.it/campusone/web_dep/wpdemb/0093.pdf

Russo, M., Whitford J. (2009). Industrial districts in a globalizing world: A model to change or a model of change? - Materiali di discussione del Dipartimento di Economia Politica (Università di Modena e Reggio Emilia), n. 615

Thomas, P. (2003). Young people, community cohesion and the role of youth work in building social capital. In: Youth and Policy, 81, 21-43

Vygotskij, L. S. (1934/1990). Pensiero e linguaggio. Laterza, Roma-Bari

Vygotskij, L. S. (1978). Mind in society. The development of higher psychological processes. In: Cole, M., John-Steiner, V., Scribner, S., Souberman, E. (eds.), Harvard University Press, Cambridge, MA.