How Collaborative Innovation and Technology in Educational Ecosystem Can Meet the Challenges Raised by the 4th Industrial Revolution

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Abstract

Nowadays, we are standing in front of the 4th Industrial Revolution that is featured by a great range of new and advanced technologies that influences all the domains of economies and industries. The great question that this revolution raises is how it can lead to a future that reflects the peoples’ common objectives and values on how these advanced technologies can affect the life and transform the economic, social, cultural, and human environment. It is commonly agreed that to be adapted to these changes and needs and shape a society with competitive economies with highly-skilled individuals, we need to encourage innovation, entrepreneurship, new knowledge generation and exchange and true and effective collaboration and communication. In this complex scene, education seems to have a central and critical role on finding new ways of developing expertise and innovation within the existing knowledge procedures, with more and better cooperation between the key players.

This paper argues the concepts, opportunities and challenges that are related to the learning ecosystem towards the needs raised by the 4th Industrial Revolution. The education is discussed as catalyst but also as carrier of innovation and innovation practices and the basis of a relevant framework is presented that takes into account all the aspects, domains and key players of educational world and interacting domains. Having introduced the ideas of innovation, collaboration and technology advancement in this environment, this paper also presents a real case of practice, focusing on how more than 5,000 schools around Europe succeeded the last four (4) years to implement innovation activities in a collaborative way and under a unique but also flexible pedagogical innovation framework.

Keywords

Learning ecosystem; Collaborative innovation; 4th Industrial Revolution

1. INTRODUCTION

It is commonly agreed and extensively discussed nowadays that we are standing in front of a revolution, the 4th Industrial Revolution, that is significantly changing the way that we live, work and relate to one another. In this new and challenging era, the experts call for leaders and citizens to “together shape a future that works for all by putting people first, empowering them and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people.” (Schwab, 2016a). These new technologies that feature the 4th Industrial Revolution are blending a variety of domains coming from the physical, digital and biological/science worlds, affecting all the areas of economy and industry.
In front of the gate of this new season the opportunities but also the challenges seem to critically affect all domains and aspects of our lives (Schwab, 2016b): the Fourth Industrial Revolution potentially raises global income levels and improve the quality of life; consumers can afford and access easily the digital world; talent, more than capital, becomes the most critical factor of production, entrepreneurship and employment raising a market going into “low-skill/low-pay” and “high-skill/high-pay” directions; the demand for highly skilled employees has increased and in parallel the need of the workers with less education and lower skills has decreased.

As a result, the first and most important challenge and goal is to lead the Fourth Industrial Revolution towards a future that reflects the peoples’ common objectives and values and to develop a common and globally comprehensive shared view of how this advanced technology can affect the live and transform the economic, social, cultural, and human environment.

To gain this common and shared view humanity needs first to be adapted to these changes so to shape a society with competitive economies and highly-skilled individuals that can handle, face and progress in front of these challenges. Toward this it is needed to encourage the innovation and new knowledge generation along with the dynamic and effective collaboration and communication. That means that we need to work on finding new ways and modes of developing expertise and innovation within the existing knowledge procedures, with more and better cooperation between the public and private sectors and the education and especially higher education (Muros and Meerman, 2016). In this process it is clear that the response to it must be integrated and comprehensive, involving all stakeholders, from the public and private sectors to academia and civil society.

Following these, the question brought by the circumstances that the Fourth Industrial Revolution for education is to understand the first the impact of these changes (Xing and Marwala, 2017) in relation to the current situation and the existing collaboration of all involved domains and stakeholders.

2. EDUCATION AS CAPALYST AND CARRIER OF INNOVATION

Educational Institutions emphasize their role in shaping future technology by being the testbeds for innovation and educating future generations (AbuMezied, 2016). Traditional education processes and tools has actually contributed with a great and very effective way to the current status and achievements of industrial evolution and advancement of technology. However, having education in a level to lead, feed and support next generations with the right and high skills we need to examine how the delivery of education needs to be transformed.

In this context, one of the major priorities is to “foster talent and skills and optimize their use” (OECD, 2015). OECD assessments show that on average, “only one-third of adults have the skills necessary for a technology-rich environment”. Broader knowledge through the built curricula, new and enhanced pedagogical practices and approaches and the development of learning tools to assess innovation-related skills are critical in all stages of education. Creativity, critical thinking, entrepreneurship and communication skills are now becoming the new major factors and skills to introduce and advance.

As mentioned, on international level, less than one-third of workers report a gap between their skills and the ones are needed for their actual job. This high mismatch represents also a barrier to the growth of industries towards innovation. In addition to this, from the collaboration aspect, the key consideration is that for the highly skilled people education should be not only efficient, but also transparent and simple, enabling movement.

Despite the clear need on innovation in all aspects of education and for all levels of learners, it is a reality that education is one of the less innovative industries among others. This makes it even more critical to import and strengthen innovation where exists, innovation in the domain.

To effectively import and support innovation we need to satisfy some critical policy dimensions (Spruijt, 2015):

- Smart infrastructure: this includes hard infrastructures,
soft infrastructures and technological infrastructures.

- **Creative cultural environment**: a well-developed entrepreneurial climate is attracting and exploiting personal talent and is reinforcing the strong culture of the community.

- **Trust**: there is considerable evidence that a trusting relationship creates greater knowledge sharing. In a trust-based relationship, people are more willing to share useful knowledge.

- **Identity**: knowledge is more effectively generated, combined and transferred by individuals who identify with a larger collective goal.

- **Diversity**: this characteristic of knowledge refers to the extent to which a variety of knowledge, know-how, and expertise is available in a network.

Beyond and supplementary to innovation we need also to **transform the educational and learning culture with strong entrepreneurship mindset**. The term “entrepreneurial mindset” refers to a particular set of attitudes, skills and behaviors that anyone can use in order to succeed academically, personally and professionally (VENTUREWELL, 2017).

This ability is fundamental for “creating” entrepreneurs looking to start new companies and personal activities, but mostly for the new professionals that target to be distinguished in a specific domain, environment or area of expertise and accelerate their career paths. Towards this, there is an urgent need for full engagement, especially of educational world, to contribute. Experience has proven that one of the best and most effective means to achieve this, is building and expanding communities of special interests, connecting their activity to the surrounding innovation community and resources. These will be the “communities of action” acting as enabling environments where people collaboratively can find how to do things (VENTUREWELL, 2017).

In supplement to this, the use of technology can help **facilitate innovation** by (a) bringing new ideas to educators, (b) documenting and sharing practices, and (c) connecting with other educational institutes and experts at international level. This is the first thing to think, since ICT has a central role in our lives and also our learning. It has been also demonstrated that different technologies and resources can make significant gains in key areas that have critical pedagogical challenges. As an outcome, technology can make a great impact on advancing learners in areas that often prove to be chasms or barriers in their developmental pathway.

### 2.1 Collaborative Innovation in Learning Ecosystem

To clearly understand and figure out how innovation can be adopted in education, we first need to have an explicit understanding on how this is defined in general and then how this is more precisely figured in the learning environment. By each own definition, innovation happens when an idea is so well...
received that it becomes a new norm in a domain and context that is applied. In addition to this, innovation as a process, is totally and tightly related to a movement and change of culture of a domain, while people rely on new ideas considered as innovations. In this process and movement to change, innovation requires from the people that participate to share their failures and successes so the well-defined ideas, experiences and concepts can become mature enough and available for broader use as innovations (European Commission, 2015).

When we think innovation in education, we need to consider these aspects described, in terms of the learning ecosystem as a “schools’ transformation” process. This transformation includes the transition from the traditional learning processes and educational systems to an open and engaging environment. This environment should bring all the stakeholders of the learning ecosystem into a shared and common site, where they share their responsibility in the learning process and they openly collaborate and interact a part of the same community with common goals.

Moving a step forward and even the importance of technology in education, innovation means much more than acquiring the latest technologies or trying a new approach. It means systematically structuring in programs and practices that promote healthy change, and new and improved approaches and the ongoing creative and productive advancement of both individuals and the organization as a whole.

Nowadays, it is a phenomenon that educational organizations tend to implement innovation through “pilot” programs or isolated activities creating “islands of innovation”, even at the level of closed teams inside the same organization. As a result, these activities do not encompass the whole organization and even worst, they do not profit the entire educational world in local, national or global levels.

To “open”, disseminate, share and take advantage from these islands of innovation, what comes as next major need, is building “collaborative innovation” actions. That, allows all the stakeholders to be valuable players across ecosystem, enables them to participate in the paths lead by the innovators and even better it makes them able to emergence new collaborative business models in the learning ecosystem (World Economic Forum, 2015). Such a culture can form the basis for educational organizations to meet the requirements and the realities of the 21st century learner by:

- Systematically structuring programs and practices that promote healthy change, new and improved approaches
- Putting in place the conditions that allow innovators to see a problem in a new light, bring to scale effective ideas, processes and solutions
- Acquiring and taking advantage from the latest technologies
- Sharing new ideas, solutions, experiences and actual material in an open environment
- Using isolated “islands of innovation” as catalyst towards Innovation

2.2 Towards Innovation: Barriers and Challenges

The barriers, issues and challenges that the world of education needs to tackle and overcome to succeed innovation, have several, complex and mixing aspects from the learners’, organizations’ and broader social environment’s views.

Focusing first on the learners’ side, we need to make them clear that education as a single dimension should not be expected to fully prepare them for their future carrier steps. To
be successful in their work they need continually change as industries transform and their achievements depend on their ability to learn throughout their life. Focus on grades often prevents them from the enjoyable side of the experience of learning that is applied in the real-world situations. Thus, education needs to move aside the traditional static assessment and lead them in a more creative way of thinking and learning (Infosys.com, 2016).

But which are actually the most important reasons that keep “teachers” and educational organizations away from innovation?

- Negative attitudes, lack of skills, complex technologies or resistance to change
- Holistic acceptance of the innovation by all actors
- A new understanding of schools is required
- Collaboration — lack of “Addressable Communities” involving stakeholders
- The R&D cycle is broken — practice, research, development, and investment are disconnected
- Language barriers and cultural differences (“consuming” existing knowledge)
- Educational policy moves to different directions than Innovation actions

The reason why an innovation may succeed in one organization but fail in another is not actually because of the vision and commitment of the leader. Instead, it’s because of its fit with “the way we do things around here” and thus, the most barrier to overcome this, is to change this culture.

Turning the attention back to the introduction and use of ICT in education as one of the most critical areas of innovation, the European Commission had already described the challenges and the trends at EU level for the current and next years.

Taking these into account that can be easily extended at a broader, global level, the focus should be paid on (Groff, 2013):

- How ICT can contribute to an increased quality in teaching and learning
- New ICT-based means for cooperation and interchange of knowledge and experience at all levels of the educational ecosystem;
- Broad access to learning materials and the development of new and varied forms of learning in order to stimulate activity, independence and cooperation;
- Students’ reflection with respect to the use of ICT in teaching and learning and in society in general;
• How to avoid creating digital divides.

Last but not least, innovation in education is about collaboration among all players, since (Office of Educational Technology, n.d.):

• **Educational partners** provide an environment where emerging learning technologies can be piloted and new solutions can be developed with input from students and teachers.

• **Research partners** conduct basic and applied research related to advancing the field of learning science.

• **Commercial partners** infuse new technologies to address problems and help scale and market successful implementations.

Collaboration between the entire research world along with the educational public organizations can create opportunities for transfer of knowledge and experiences. The main vehicle towards this is by creating new partnerships, establishing inter-disciplinary research initiatives, and further expanding already established networks. From the other side, research and industry often gave conflicting views on their purposes and expectations from the educational environment including research and learning process. In this case, collaboration becomes the key challenge and the major necessity (Bramwell et al., 2012).

**2.3 Figuring the Innovation Framework**

Taking into account all the opportunities and challenges that the 4th Industrial Revolution introduces, towards the need of an innovation framework for education, one major question rise, “How?” It is critical that no definitive model has been proposed or established so far for an optimal innovation ecosystem. This depends on both the level of development and the nature of broader political, economic and social systems. To ensure in a great extent that all mentioned factors and dimensions are considered under this framework, three areas of actions should be covered as described in the next paragraphs.
A. **Build a clear strategy** towards Innovation from the holistic perspective to achieve “comprehensive” innovation in the learning ecosystem, so the involved people grow around innovation islands (HLG Secretariat, 2014):

- Clear roles, expectations and involvement of all relevant stakeholders
- Focus on identify and foster the development of 21st century skills and competencies, addressing the second digital divide
- Raise awareness among educators, parents and policy-makers of the consequences of increasing ICT familiarity
- Support school leaders capture innovation, to decide on the appropriate strategy to diffuse innovation to the school
- Provide support mechanism with proper tools for each step of Innovation path
- Define your clear needs to select the proper tools
- Think Innovation as an endless process – constant reflection guides towards the transformation of the school to learning commons and finally to sustainable innovation ecosystems

B. **Take advantage from the “islands of Innovation” and make the innovators the leaders** in the path:

Transformation of an ecosystem is featured by a non-ending realignment of relationships of people, knowledge and resources for incremental and transformational value co-creation. Since innovation is a dynamic process, it depends critically on creating the right conditions, especially from a policy perspective. Through these conditions and relationships, value co-creation networks evolve that are beneficial for people, public sector, educational institutes, companies and investment organizations (KEN Forum, 2014). In this great and complex environment, different categories of people have different motivations and concerns. It would be a mistake trying to get the late majority on board with the same arguments than convinced the innovators or early adopters. Creating innovation hubs is the more efficient way to mediate knowledge and facilitate them for purposes of innovation. This process involves strengthening existing and creating new networks of communities that enable the various players to find and play their role, take advantage from the “best practices” and spread their owns and to communicate and learn each other.

C. **Offer adaptive, personalized and accessible services** for the digital learning environments to support the local needs:

Technology helps facilitate innovating at the local context by bringing new ideas to educators, documenting and sharing practices, and connecting with other schools and professionals around the globe. When building learning environments for educational purposes it is necessary to follow and satisfy a set of directions that ensure the effective use of learning ser-

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services towards a collaborative and innovative ecosystem (OECD, 2017)
- Not all students learn in the same way (behavioral, performance, cognitive & physiological attributes). What makes great teachers great is their ability to approximate this personalized learning experience in a classroom with 30 students.” (Kinshuk, 2016). Success of learning in different scenarios depends on appropriate application of adaptivity and personalization to suit the context of that particular scenario.
- Ensure that all learners and instructors are able to participate, with access to content and the ability to create accessible learning artifacts.
- Enable teachers to find learning content created by other teachers and provide means to create and share their own. Reusability goes then beyond learning materials to activities and even further to learning scenarios and projects.
- Provide reliable measurements for effective assessment.

From a methodological point of view, most of the innovative methods are difficult to evaluate quantitatively using observational data (EENEE, 2015). Several reasons contribute on this. E.g. concepts like project based learning are difficult to distinguish from other teaching and learning methods which are difficult to measure in what extent are applied or not. Systematic and scientifically documented methods are needed in conjunction with the use of advanced ICT tools and methodologies.
- The main goal: increase students’ efficiency, effectiveness and satisfaction

3. COLLABORATIVE INNOVATION IN PRACTICE: A REAL CASE

The concepts presented in the previous paragraphs combine a holistic approach of the needs, trends and opportunities in the learning ecosystem to achieve innovation in practice and face the challenges towards the new era figured by the 4th Industrial Revolution. The case presented in the current section is a demonstration of all these aspects from its theoretical and also implementation aspects in real world conditions.

This real case is originated by the implementation of two large scale pilot projects, the Open Discovery Space (ODS, http://portal.opendiscoveryspace.eu/en) and the Inspiring Science Education (ISE, http://portal.opendiscoveryspace.eu/en/ise) implemented the previous years (from April 2012 to July 2016). In these two projects, more than 5,000 schools participated throughout Europe demonstrating an Innovation Framework that follows the principles presented in Section

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1 http://cordis.europa.eu/project/rcn/191912_en.html
2 http://cordis.europa.eu/project/rcn/191938_en.html
2.3. During these years, the piloting teachers, students and schools carried out a variety of learning activities, applying and using a variety of technology-rich and innovative practices and tools. These activities were designed and took place based on a properly implemented pedagogical framework, that targeted on the creation of an open and collaborative school environment. The main challenge was the large-scale implementation of an open-scale methodology relevant to technology-supported innovation through the experimentation in the use of online tools and labs, along with the establishment of novel practices in assessment using and producing standardized methodologies and tools (Zervas et al., 2015b).

3.1 The Pedagogical Framework

The pedagogical framework designed during the implementation of the ODS project and applied in both ODS and ISE through the project activities and large scale pilots with the participating community of practice, is described by the ODS Innovation model (Chelioti et al., 2015). This model documents the phases, processes, tools and actors that take part in the innovation process. This innovation process facilitates the innovators to design and share their own learning material and activities, being in close collaboration with the local and regional communities as well as with the online communities at EU level. Along with the technical tools and services implemented by both projects, this Innovation Model constitute a consistent pedagogical framework that sets the basis for the development of innovation activities. The implementation of the Innovation Model in real settings allows and achieved: embed online labs in structured learning spaces, integrate these spaces to classroom activities and create opportunities for social interaction, networking and sharing for educators and learners.

The three phases of Innovation Model are described as follow:
• The stimulation phase is focusing on the analysis of the school needs and has the aim to identify areas in which the school can best demonstrate innovative approaches and projects
• The incubation phase aims to diffuse innovative practices in numerous areas (curriculum, parental engagement, interactions with actors outside from the school) of the school operation
• The objective of the acceleration phase is to accelerate the educational changes regarded as effective and to expand them to significant parts of the school, always keeping in mind the school’s main needs

3.2 The Social Service and Tools

The services and tools provided by both projects to supplementary support the implementation of the Innovation Model in the schools participated, are provided by a unique platform, the ODS/ISE platform (http://portal.opendiscoveryspace.eu/). This is a social-based community platform that supports teachers to create new learning processes and material for bringing Innovation in classrooms with the design and implementation of various activities (Zervas et al., 2015a). The teachers, as the key actors in this platform, are fully profiled and supported in order to assess and improve their professional development building and updating their competence profile (UNESCO, 2011).

Following the principles of the established pedagogical framework, the platform offers to the teachers an environment to participate in a dynamically expanded collaborative network of School/thematic/national communities, that are internally well structured and organized based on the activities and the content that each community implements/uses/publishes in open or private mode. These communities are open to all the relevant stakeholders of the educational environment and they allow to their members to organize their groups or classrooms in terms of students and content, learning scenarios and tools. The services provided at the top of the communities facilitate the schools / teachers to discover, mix and re-use of learning content, eLearning tools and contextual data through a set of authoring tools. These tools support them to produce new learning scenarios, educational content and lesson plans. Along with the community building services, the platform supports the teachers to increase their professional development following a variety of training material in the academies provided, in a personalized manner, since these are related on their competence profile. IDS/ISE platform is actually a federation of online labs & learning resources organized in such a way to facilitate pedagogical plug and play.
Fig. 10. The conceptual framework of ODS/ISE platform

Source: authors

Fig. 11. The architectural framework of ODS/ISE platform

Source: authors
in classrooms. This platform offers in advance special services for analytics in the use of the provided services and relevant reporting and visualization tools, that is a significant mean for the systematic assessment of the learning achievements through the real use and lessons/implementation (OECD, 2009; Annagar and Tiemann, 2016).

### 3.3 The Community of Practice

Under this holistic pedagogical and technical framework that defines standardized methodologies and tools, more than 10,000 teachers from more than 5,000 schools throughout Europe (more than 25 countries) interconnected and co-worked, with the involvement also of more than 40,000 students. This great community validated the designed, implemented and fully supported community building concept of the Innovation Model. The network of teachers and schools was created and is still working using the services provided by the ODS/ISE platform, through more than 1,200 live communities. These communities are expanded at local, national, thematic and school(s) levels, involving stakeholders at both local and national levels. The teachers are sharing and reusing new and existing educational resources and scenarios and they build collaborations on various domains and subjects under Science, Music, Business Studies, Mathematics, Technology, Social Studies, Foreign Language Learning, Special Education and Religious Education domains (Riviou et al., 2014).

The case that is presented by this community of practice, is a real example and best practice of collaborative innovation that is developed under a well-defined and structured pedagogical framework. The assessment results collected and evaluated through the implementation of these activities proved that this kind of pedagogical framework, along with the proper tools and services provided to the schools' environment can achieve: (a) effective and smooth introduction of ICT in these environments, (b) active involvement of all the stakeholders in the innovation process and (c) implementation of innovation actions in and classroom’s real settings.

### 4. CONCLUSIVE REMARKS

The 4th Industrial Revolution introduces significant challenges and new conditions for growth at social and economic levels and dramatically affects the everyday life and peoples’ careers. This new scene rises the necessity of building a next generation of learners and workers that are qualified to face these changes and also contribute in the future improvements and progress. In front of these conditions and needs the change of education towards an innovative and collaborative environment becomes at the top of the proprieties.

Education can be the vehicle and also the testbed for the in-
troduction and application of new concepts and advanced methodologies and technologies, towards the creation of high-skilled learners and workers. The main goal is to facilitate them to implement and improve from the early stages of educational process their creative and innovative way of thinking and learning for life. This new mindset is necessary to boost the effective use and extension of the means that the 4th Industrial Revolution provides to the humanity and it is a step forward to the future entrepreneurship world and the learning ecosystem.

Towards this, an innovative educational ecosystem can be built with (a) clear strategies, (b) taking advantage from the “islands of innovation” making the innovators the leaders in the path, (c) extended built of communities of practices and collaboration schemes and (d) the provision of adaptive, personalized and accessible services for the digital learning environment.

The latest experiences from the implementation of two large scaled pilot projects of ODS and ISE in the area of eLearning with the participation of more than 10.000 teachers and a great number of experts and representatives from local and public communities, have proven that the collaboration and the guidance of the communities of practice from the early adopters and the innovators are the key to succeed the implementation of innovative learning activities at local and more extended levels under a well-defined pedagogical framework.

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