Routledge
Taylor & Francis Group

The Design Journal
An International Journal for All Aspects of Design

ISSN: 1460-6925 (Print) 1756-3062 (Online) Journal homepage: https://www.tandfonline.com/loi/rfdj20

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Carmen Bruno & Marita Canina

To cite this article: Carmen Bruno & Marita Canina (2019) Creativity 4.0. Empowering creative process for digitally enhanced people, The Design Journal, 22:sup1, 2119-2131, DOI: 10.1080/14606925.2019.1594935

To link to this article: https://doi.org/10.1080/14606925.2019.1594935

EAD 2019

Running with Scissors, 13th International Conference of the EAD, University of Dundee, 10-12 April 2019

Creativity 4.0. Empowering creative process for digitally enhanced people

Carmen Bruno[a*], Marita Canina[a]

[a]IDEActivity Center, Design Department, Politecnico di Milano
*Corresponding author e-mail: carmen.bruno@polimi.it

Abstract: Creativity - the ability to produce novel and useful ideas – has become a democratic necessity and the most important human skill to face the uncertainties brought by the digital era we are going through.
This era and its digital technologies are reshaping the social, behavioural and cognitive development of digitally enhanced individuals who are growing up with digital habits. The fundamental questions that arises from this context are about the effects of the technological evolution on the creative thinking abilities of the digitally enhanced generation. What are the positive and negative impact on creativity brought by digital technology? Through a Creative 4.0 model, built from the analysis of the current scenario of transition, the paper presents an overview and some preliminary reflections about the changes that the digital technological evolution of our century is bringing on human creativity, particularly on the creative design process.

Keywords: Creativity 4.0, Digital technology, Creative design process, Digitally enhanced people, Creativity enablers

1. Introduction

We are going through a digital transition century in which digital technologies (i.e., IoT, AI, VR, etc…) are totally reshaping the way in which people live and learn, the way they work and socialize. Human being is living in an *onlife* (Floridi, 2015) reality, a new experience of a hyperconnected reality that is modelling our digital culture and affecting the social, behavioural and cognitive development of digitally enhanced individuals (Prensky, 2001a), who are growing up with digital habits (smartphones, tablets, video games, etc.).

This digital transition is radically impacting the human condition in profound ways on three main levels:

- The cognitive level, the way in which we learn and process information.
- The individual level as human being interacting with the world.
- The social level intended as being part of a community.

In this transition, creativity has been recognized as one of the most important human skill to face the complexity brought by the digital era we are going through. It has become a democratic necessity

which helps people in generating novel and useful ideas (Amabile, 1988), and get the advantage of the opportunities offered by digital technologies in any field.

The fundamental questions that arise from this context are about the effects of the technological evolution on the creative thinking abilities of the digitally enhanced generation. How does creativity is changing accordingly to digital changes? What are the positive and negative impacts on creativity brought by digital technology?

It is therefore fundamental to understand what is happening during this transition in order to actively manage and lead these changes, to gain benefit from it. We are all moving toward digital enhancement (Prensky, 2009) and school, companies, organizations should be able to train, collaborate and interact with a digital generation representing the main actors of a near future.

For that reason, the objective of the paper is to present an overview and some preliminary reflections about the changes that the digital technological evolution of our century is bringing on human creativity, particularly on the creative design process.

The analysis of the current scenario of transition enabled us to build a model through which it will be possible to understand how the concept of creativity is changing, identifying the crucial factors that affect creativity in this era.

The **Creativity 4.0 Model** (figure 1) is structured through three main elements: the *digital transition*, that is the ground on which the model is growing and feeding; the *human being* which is analysed according to the three levels on which the digital transition has impacts (cognitive, individual, social) and finally, the *creativity* as a human skill and therefore transversal to all the levels of human being.

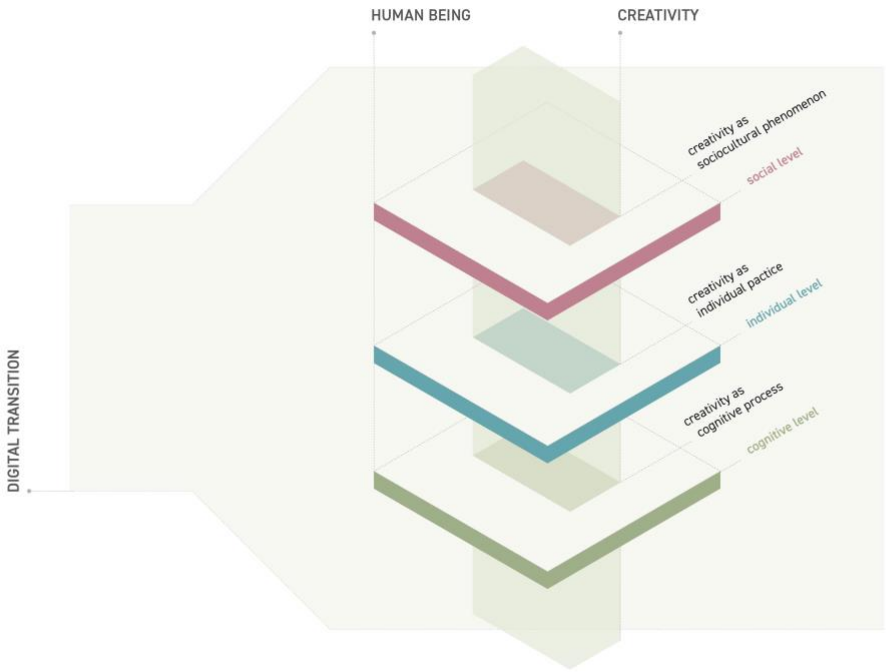

Figure 1. Representation of the Creativity 4.0 model

The Creativity 4.0 Model, therefore, enables to explore how the concept of creativity is changing in the digital transition according to the three human levels mentioned above, which include:

- Creativity understood as a cognitive process.
- Creativity as an individual practice carried out by the individual.
- Creativity as a sociocultural phenomenon happening with others inside the society.

The realm of creativity studies is very broad, and its investigation is a huge work that requires a structured exploratory framework. That is why we decided to create the model that is the result of a deep work of reflections after the extensive literature investigation. It is here presented in the introduction in order to help readers in fluently go through the paper and having a better understanding of the research done.

2. The digital transition

In the XXI century, the connections between humans depend on their ability to exchange information and the way they communicate. Today we are dealing with **ICTs-driven societies** (Floridi, 2015), in which human societies become vitally dependent on them and on information as a fundamental resource.

This century has seen the introduction of completely new devices, sensors, robots, and applications that are blurring the distinction between reality and virtuality. In this *onlife* world it is no longer sensible to ask whether one may be online or offline (Floridi, 2015)

Digital technology is becoming our *next nature*, a nature that is caused by people and that, as nature does, goes beyond our control (Mensvoort, 2011). In this context, the distinction between human, machine, and nature become blurred (Dourish and Bell, 2011) and technology becomes much more intrinsic, invisible and totally embedded in our lives that we don't even recognize it anymore as technology.

Virtual, Augmented and Mixed Reality, as well as the Internet of Things, have increasingly become something of a fascination for individual, society, and companies (H-Farm, 2018). Today we are used to interacting with many different things in our lives: our phones, computers, televisions and almost every aspect of our homes are too. This has caused a shift in understanding, expectations, and culture.

This digital transition, intended as the societal process arising from the diffusion and adoption of ICTs, it is profoundly changing the human condition. The human being is co-evolving with technology (Corazza, 2017) as it modifies our "relationships to ourselves (who we are), the interaction with others (how we socialize), our conception and interaction to the real world" (Floridi, 2015, p.7)

All these important changes are raising a set of fundamental questions, and discussions, both at the individual and relational levels, that invest the realms of psychology, sociology, education. Above all, many researchers are questioning about the impact of ICTs on human cognition, especially in terms of brain modification and changes in cognitive processes. Neuroscientists are beginning to see significant changes which correlate with the rise of the digital technologies and their widespread adoption.

Important questions are arising also in relation to the social behavioural changes and the shift in mindset. The rise of the so-called digital culture has seen a democratization of technological tools and therefore their adoption by a large number of people. This has led to the creation of a new social phenomenon, initiatives and communities (e.g., open source, peer-to-peer, etc) emerging with the aim of contributing to a more community-oriented society (Florida, 2014).

The emerging digital technologies have the potential to revolutionize all sectors of our society (i.e. healthcare, transportation, manufacturing, entertainment, and even art), playing a key role in the creation of new business models and transforming the industrial economy and the associated job market (National Research Council, 2008). Think about UX designer, social media manager, Uber driver, drone operator, these are roles in today's market that were practically uncharted a decade ago. The digital economy is transforming the way people work, learn, behave, socialize, and also the skills they need to thrive in an increasingly complex world. Major digital transformations such as Artificial Intelligence (AI), machine learning, big data analytics, change skills requirements and, in turn, impact capacity building and skills development for the 21st-century digital economy.

From this overview the research is oriented in explaining the changes of the individual both at the cognitive level and the skills abilities, moving through great social changes. Therefore, in this context, creativity has been rightly recognized as a key to economic growth and social transformation (Florida, 2014) since it represents the intangible substrate for innovation (Kozbelt, et al, 2010). To move forward in better comprehension of the Creativity 4.0 model, it is fundamental to understand some basic concept of creativity.

3. Creativity as a human relevant skill

It is necessary to put the human creativity at the centre of the digital transition because it is an increasingly essential skill for our survival in this era especially in the necessary collaboration between humans and machines (Corazza, 2017). Innovation today doesn't solely rely on the technology itself, but mainly on how it interacts with humanity, solving their problems, needs or challenges. Innovation is driven by human creativity that is that spontaneous act pushed by intrinsic motivation, through which the individual can improve itself and his world. Therefore, it is important to understand what creativity is, highlighting some basic concept that will then allow understanding the changing elements and needs required by the digital context.

The creativity concept has been widely studied since a long time and is constantly changing according to the socio-cultural environment around us (Runco, 2017). Since it is a complex and multidimensional concept, a lot of definitions has been proposed.

According to the standard definition of creativity (Runco, 2012), widely adopted, creativity is an ability to discover something new, to adapt the available knowledge purposefully and solve the problems originally, flexibly and effectively. This involves the development of a – less than linear – process of information collection, selection, reconfiguration, and identification of the relationships generating new results (Testa 2011).

Poincaré (1924) considered creativity as the ability to recognize the usefulness of new configurations of existing elements. He considers creativity as a skill that is based on the ability to "disconnect" and reconnect existing element of knowledge with each other, by association, according to schemes never used before. The first reference to a multiphase structure of the creative process to solve mathematical problems refers to him. Wallas (1926), inspired by his work, divided the creative process into four phases: preparation, incubation, illumination, and verification. This classification was the starting point for researches in the field of creativity in design to define new models to better describe process phases.

An important work in the field of creativity studies has been done by Amabile (1988) which considered creativity as the production of novel and useful ideas by an individual or small group of individuals working together. She developed an individual model of creativity (Amabile, 2012)

composed by the creative process and the basic factors influencing creativity throughout the process. Three factors are considered within the individual - domain-relevant skills, creative thinking skills, intrinsic motivation - and one outside the individual - the social environments.

Within the creativity literature, many research (Csikszentmihalyi, 1996; Ekvall, 1966) investigate the factors influencing creativity also in specific contexts. These factors, not intentionally described in this paper, have been collected throughout the investigation, in order to further develop the model presented.

It is possible to stimulate creative thinking, both on an individual and group level, by using valuable techniques and methodologies, with the aim of promoting and generating creativity, breaking pre-established patterns, stimulating the imagination and improving the conditions in which the creative idea is produced.

This methods and techniques have been developed to overcome the conceptual blocks which are the "mental wall" that blocks the problem-solver from correctly perceiving a problem or conceiving its solution (Roth, 1973). Roth argues that despite the mental inflexibility which is the primary cause of conceptual blocking, many other blocks have been identified such as emotional, environmental, cultural and intellectual blocks.

When we define creativity and innovation, it is essential to take into consideration the social, cultural and economic context in which we live. In fact, with human evolution, there are new domains in which creativity is often expressed, such as politics, digital technology, moral and everyday creativity (Runco, 2017) that also led to the definition of new methodologies for its investigation (Williams, et al, 2016)

This means that the definitions of creativity evolve and fluctuate over time, and it's fundamental to study and understand how it changes as it is a fundamental skill that can guide the human being throughout its evolution. One interesting work in this direction has been done by Williams et al (2016) which create an interactive map through which it is possible to see how research interest in creative studies has evolved over the last 25 years as well as the research focus.

In the last decades and in particular with the advent of ICTs and more recently with the diffusion and the democratization of digital technologies of production and sharing, the people and the society has started a process of transformation becoming more and more interconnected. Understanding the human being transformation is a fundamental step for analyzing how creativity has evolved.

4. Co-evolution of digital technology and human being

The human being is another structural component of the model. This chapter aims to highlight the impact that digital technology is having on human beings according to the 3 levels defined within the Creativity 4.0 model. Therefore, it will be evident how, with the evolution of technology, society and human skills evolve accordingly. First with the advent of the Internet, and now with all the other new advanced digital technologies, human evolution has been more than ever disruptive, studied and observed.

More than 20 years ago researchers, especially from the pedagogical field, start talking about the rise of a 'Net generation' (Tapscott, 1998) named also 'digital natives' (Prensky, 2001a) or 'millennials' (Howe and Strauss, 2000). They were defined as the first group to come of age after the arrival of digital technology, bringing with them heightened expectations of immediacy, participation, and transparency. Described as optimistic, team-oriented achievers who are talented with technology

and digitally skilled, they exhibit different consumption behaviours, learning preferences and work style, compared with previous generations (Bakhshi, et al, 2017).

These aspects are widely discussed in the literature since are contemporary issues related to education and training. The old approach to education is ill-suited to the intellectual, social, motivational, and emotional needs of the new generation. In the 21st century, there are fundamental changes for these people that are held to be active experiential learners, proficient in multitasking, and dependent on communications technologies for accessing information and for interacting with others (Frand,2000; Oblinger & Oblinger, 2005; Prensky, 2001a, b; Tapscott, 1998).

As we move further into the 21st century, the concept of digital native is evolving since all are growing up in the era of digital technology. Prensky (2009) suggest that in this century a new distinction can be done in terms of digital wisdom. We can call them digitally enhanced people

> "he or she accepts digital enhancement as an integral fact of human existence, and he or she is digitally wise, both in the considered way he or she accesses the power of digital enhancements to complement innate abilities and in the way in which he or she uses enhancements to facilitate wiser decision making." (Prensky, 2009, p. 4).

The main hypothesis that arises from this context is that it could be necessary to develop new creativity stimuli for the digital generation according to the digital cultural changes and the cognitive shift occurred.

To further investigates this hypothesis, it is fundamental to understand the impacts of digital technology on the cognitive, individual and social level of human being.

4.1 Digital transition on the cognitive level

Throughout the human being evolution, our cognitive systems have been altered by the advent of technological inventions such as primitive tools, spoken language, and writing. About 30 years ago, the advent of the Internet, as well as the contemporary mass adoption of other digital technologies, has profoundly transformed our thoughts and behaviours and probably our brain which is generally understood to be highly plastic, continually adapting to the input it receives (Thompson, 2013). According to this idea, we could probably assume that the brains of digitally enhanced people, who interact with digital technology frequently, will be probably organized and structured differently compared to the brains of the previous generation. This reflection has moved neuroscientists to widely study the impact of the Internet environment on our cognitive behaviours and structures.

Here are shown some positive and negative effects that ICTs have on human cognition, and opposite views about the structural changes in the brain. These have been extrapolated by few empirical studied in this field.

Among the negative effects several authors (Abelson, et al, 2008; Carr, 2008; Jackson, 2008; Keen, 2007; Siegel, 2008) have argued that digitally enhanced people have not the ability to maintain the same focus and attention of previous generations when reading traditional text. In addition, Small and Vorgan (2008, p 4–6) sustain that overexposure can alter brain regions that control mood and thought, with potential for deleterious results. However, opposite view sustains that the brain is elastic enough to recover quickly from overexposure (Rubin, 2012, p. 254). The recovery is supported by the way in which information are presented on a screen and by the possibility of intermittent naps (Mednick and Ehrman, 2002). Moreover, the everyday use of computers stimulates areas of the brain that reading in the traditional sense doesn't (Small and Vorgan, 2008).

According to the review done by Loh e Kanai (2016), the Internet environment has altered the cognitive behaviours and structures involved in **information processing, executive control, and reward-processing.** The hypertext environments and the easier retrieval of online information result in a reduced learning effort causing a shift toward a "**shallow mode" of learning** characterized by **quick scanning, reduced contemplation**, and **memory consolidation**. Interrupting the development of deep reading skills, may accelerate this process.

Internet technologies also greatly facilitate **multitasking behaviours** that have been linked with increased distractibility and reduced learning, especially in the classroom, but in better integration of multiple sources of information. Researchers have noted the **importance of motivation, and positive affect in moderating the distractibility by the Internet technology.** An interesting finding is **that multitasking with action video games** can produce improvements in attention abilities suggesting that exposure to different forms of multitasking can lead to different cognitive effects.

Finally, **the mechanisms of rewarding** offered by Internet environment has altered the brain networks involved in self-control and reward-processing, with a potentially dangerous increase of Internet-related addictive behaviours.

The central question that arises from these considerations is about how the creative thinking abilities of the digital generation, change according to the cognitive changes occurred. Chapter 5 will report the findings of the research at this level.

4.2 Digital transition on the individual level

The digital realm is an environment where online and offline activities meld and morph within distributed networks afforded by mobile devices, social media and ICTs (DiDIY, 2017).

This kind of hybridity characterizing our lives is enabling new ways of engagement and participation for the individual, facilitating new forms of expression and is contributing to redefine an evolved concept of work. At the same time, some digital tools (e.g., 3D printers) and technologies tend to allow for a lack of manual skills, thus distributing the competences between the human and the machine.

In a digital transition era, we are assisting at a transformation of the industrial economy and consequently of employment. There is a strong demand of a set of new skills to master new digital devices and technologies and to face the complexity brought by this transition. Future citizens will have to take a lot more decisions than they do today, more frequently, and these skills are fundamental to face a continuous and ever-changing environment. They are defined as digital skills or 21st-century skills and not only include the abilities to use digital devices, but also a set of soft and cognitive skills such as critical thinking, creativity, complex problem solving, collaboration abilities, and socio-emotional skills (The Partnership of 21st Century Skills, 2008). They enable people to create and share digital content but also to communicate, collaborate, and solve problems for effective and creative self-fulfilment in life, learning, work, and social activities at large, taking advantage of digital technologies potentialities. The development of such skills represents today a major challenge for companies, schools, and public authorities.

In contrast with the conception of consumers or more in general people to be passive receivers, the digital transition has its emphasis on "doing" and the active roles. Motivation is an aspect that appears to be necessary to activate people interest in a challenge, project or a community. Motivational aspects are believed to be crucial also for keeping the active role over time and to persevere in overcoming the difficulties related to self-organization, use of spare time, and social

interactions in collaborations. Of particular importance are the rewarding sensation of being with the others, and the interest of generating a positive social impact.

4.3 Digital transition on the social level

Digital technology can break down geographical borders enabling the increased connectivity among individuals who support each other in “creative communities”, i.e., groups of people who cooperatively invent, enhance and manage innovative solutions for social challenges. This can result in the creation of new ways of collaborating, and the growing of shared knowledge which supports the global expansion of different local communities’ ideas and projects.

ICT, creative platforms and social media has contributed to the spreading of groups who collaborate on a wide scale, often at a global level, for shared purposes. This scenario open opportunities for more people to engage in creative activities that permit them to exhibit and experience virtuous behaviour (Benkler and Nissenbaum, 2006).

The widespread availability of networked digital information processors and the interest to share knowledge have created a new dimension in which the person can be a group, a class, a community of practice, a company, an industrial cluster, the society as such.

The transdisciplinary collaboration among people is believed to be the most significant element characterising the evolution of traditional technologies toward the digital one.

Digital technologies allow to democratize activity and process in a number of ways: giving people independence and self-reliance, encouraging the wider dissemination and adoption of creative behaviour, providing an opportunity to create more personal meaning in their own environments or self-identity, and opening up previously gendered or class-bound activities to all (Atkinson, 2006).

To meet the changes of this social transition is important to learn how to manage creativity as well as the digital technologies.

5. Creativity 4.0 Model

After the analysis of all the structural elements, the Creativity 4.0 model is framed to allow the identification of the positive and negative consequences of the digital transition on creativity. The model represents a framework for organizing this knowledge.

The model enables the integration and interpretation of the creativity factors, blocks and conditions that can boost or lock creativity on the three levels. Boundaries between such levels are often blurred and the allocation of the elements may be challenging. However, acknowledging their existence and close interaction, facilitates the comprehension of the complexity and multifarious aspects of both the human being and the creativity skill. The reflection presented in this chapter has been collected through a literature review of studies that have already investigated the impact of technologies on creativity from a theoretical point of view or by analysing specific contexts (i.e. work, education). At this point, the spectrum of research has been deliberately kept open, without focusing on a specific field, because of a lack of research in progress due to its contemporary nature.

Starting from the **cognitive level**, Johnson (2006), reports that the increasing synaptic activity in areas of the brain with digital exposure has an intuitive relationship with the potential to come up with innovative ways to connect old ideas and may contribute to expanding possibilities for creative activity.

We have already discussed before about the shift towards a "shallow mode" of learning of the digitally enhanced generation in which there could be a loss in the deep reading abilities. Johnson (2006, p. 22) tells us how reading can start a mental work of processing and storing information, **invoking powers of imagination**, **crossing ideas from different disciplines**, that have allowed a new synaptic configuration over time. A decreasing of the deep reading abilities, cause drastic consequences not on the ability to create but on the quality of creation, given by the inability to select the most interesting and appropriate information. This inability increases exponentially also due to the amount of information easily available on the Internet. The resulted **information overload** blows up the divergent phase of the creative process, creating difficulties in integrating the information when attempting to form new ideas (Huber, 1990). The shallow mode of learning is also connected to a reduction in long-term memory which could have repercussions on the development of the individual culture, important for the quality and the originality of a project (Mu Tian, et al, 2018).

However, ICT technologies in some cases can help in fighting some creativity mental blocks, such as the fear of something, that according to the psychologist Bandura (1982) is one of the human blocks that can be defeated in order to empower our creative confidence (Kelley and Kelley, 2013). The immersive alternative realities, such as Virtual Reality, constitute environments with different rules in which people can take on alternative roles' personalities allowing a perspective shift with respect to the available information. In this environment, "divergent thinking can be facilitated by taking on different roles and generating ideas which are pertinent to the role" (Corazza and Agnoli, 2015, p.5)

As discussed in 4.2, motivation is a key driver of the creative process at the **individual level.** Rubin (2012) is questioning about if there are changes in the motivations that drive creativity in these times:

> "Power, curiosity, intellectual evolution, and hunger for new experiences, which relate to Franken's (2006) and Magyari-Beck's (1996) motivating factors, still form the foundations upon which creativity is acted on today. Although the digital landscape has dramatically changed how people are spending their time, those underlying motivations are still prevalent".

Intrinsic motivations are strictly related to the challenge itself. What is probably changing are the extrinsic motivations, more related to the surrounding environment, that drives digitally enhanced people in starting a creative process.

According to Greene (2002) the digital environments support creativity in the design process in knowledge gathering, knowledge sharing and knowledge integration, and in idea generation. Digital devices have the potential to boost individual creativity because they provide people with access to new and diverse information (Oldham and Da Silva, 2016) from a variety of sources. From knowledge repositories and information specialists (Dewett, 2003) to a broad network of diverse non-specialists who might have different ideas or perspectives, necessary to develop fresh new ideas. Ideas and information collected are available immediately, allowing for fast elaboration and integration. The result of interaction with multiple people, possibly with different cultural backgrounds, can generate new ideas and focus areas at the initial stage of the process, favouring the so-called **brokerage of knowledge** (Corazza and Agnoli, 2015, p.4). The social factors of creativity, which include for example the ideas sharing with others, the support on your ideas, the collection of feedback from others, have been increasingly empowered by digital technologies.

Going to the **social level**, ICTs provided new opportunities for creative networking and can expand group creativity and therefore social creativity (Fischer, 2004). Fischer, Rohde, and Wulf (2007)

defined the term social creativity as working together to solve a problem with the help of computer media and technologies. Although creative individuals (Gardner, 1993; Sternberg, 1988) are often thought of as working in isolation, much of our intelligence and creativity results from interaction and collaboration with other individuals (Csikszentmihalyi, 1996) exploiting the spatial, temporal, conceptual and technological barriers (Fischer,2005) caused by distances as sources of new and innovative ideas.

The emergence, development and widespread use of the Internet and digital media are key markers for the generation of new social paradigm, the We-paradigm (Glăveanu, 2010), in which creativity is defined in terms of communication and interaction and developed through collaborative relations. ICTs led to a transformation of creative activities and their outcomes, from the emergence of new types of creative products to the increased quality and speed of exchanges within creative teams. Let's think about how the democratization of some digital technologies, such as 3dprinters, cnc machine, online platform, is generating the rise of new social phenomenon, linked to create and make, which allowed the increasing of a diffused creativity within the society.

In this era, the internet is a fundamental part of today's global culture and ICTs allow for an increasing connection of people and ideas, fostering online activism, information sharing and facilitating collaboration both within the digital world and beyond it. All these features have impacts on creativity as a phenomenon and redefine it "as the processes of creatively collaborating with others find themselves mediated by technological means" (Literat and Glăveanu, 2016, p 331).

6. Conclusion and future actions

The definition of the creativity 4.0 model is the starting point of a broader study which aims to define a framework that could empower the creative expression of the digitally enhanced people within the design process to develop new and useful ideas.

Empowering people with creativity skill becomes for designers a fundamental aim and a new field of action. Also, for the design research, it has become essential to understand the impact of digital technologies on the creative design process to: update the conceptual toolbox; facilitate people creative potential to reach the best performance in each step of the process; address new technological challenges generating positive implications and large-scale innovation.

The ever-changing digital scenario will constantly require people a deeply understanding of the potentialities of its digital technologies and the social and cultural opportunities that they could bring in order to anticipating future needs and opportunities. This requirement could probably lead to an evolved creative design process where a pre-phase of immersion in the digital technologies become fundamental to inform and spark the entire process to obtain successful results. This new pre-step will also be fundamental to early identify a vision to explore along with the motivation to generate in that particular area.

The generated framework will benefit several context and disciplines, and open opportunities for other future researches. To make some example, in the work field, the framework could help companies to include a new generation of workers creating the proper work condition to spark their creativity; it could support companies aiming exploring and anticipate opportunities and needs and adopting cutting-edge technologies at their service. In the design education field, it could shape new design tools and actions to support designers at all stages of the design process.

Future actions of the research will compare and verify the literature findings with case studies from the design practice to define guidelines that will highlight the opportunities to overcome blocks enhancing creativity within the design process.

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