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Creativity in the Fourth Industrial Curricula with Artificially Intelligent Technologies

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Abstract

Artificial intelligence has become pervasive in the Fourth Industrial Revolution (4IR) and is challenging traditional notions of what it means to be creative. This paper suggests newer and nuanced ways of conceiving creativity in the 4IR era dominated by artificially intelligent systems that are capable of creative outputs. An integrative literature review of the notion of creativity is done to ascertain what it entails to be creative in the 4IR learning context. The Actor-Network Theory is used to sustain a proposed framework for understanding creativity in the 4IR skills development context. It is argued that skills development in the 4IR is happening in an era where humanity is deeply entangled with intelligent machines. A proposal is put suggesting that creativity in learning contexts should go beyond the confines of the mind contrary to traditional pedagogical thinking. Creative learning in the 4IR should be driven by thought processes, human beings' inherent crafting capabilities, and the computing power of artificial intelligence. Consequently, the design of learning programmes and skills development in the 4IR should occur in a framework that appreciates the fact that creative abilities have moved past capabilities of the human mind. In addition to mental acts, creativity involves the human beings' manipulative abilities as well as the computing power of artificially intelligent systems. 4IR researchers are encouraged to develop newer lenses and paradigms of understanding and defining creativity in the 4IRskills development context taking into consideration the pervasiveness and creative capabilities of artificially intelligent technologies. The age of the machines has arrived, much of what is taught, and learned, and the creative approaches used to arrive at solutions is changing together with what it means to be creative. Research effort should be directed towards developing educational methodologies that shift skills development systems, so stuck in traditional pedagogies that prime the human mind as the custodian of creativity, to philosophies and theories that are compatible with the 4IR such as post-humanism and connectivism

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1 Introduction

The Fourth Industrial Revolution (4IR) curriculum is being conceived and implemented in a period of major disruptions to societal traditions and educational practices because of technology. What is learned, how it is learned, and how it is assessed should, consequently, be changing. A scoping review of critical skills and competencies of the 4IR by Chaka (2020) primes generic soft skills namely communication, creativity, and problem-solving together with hard skills such as computer programming. The 4IR curriculum is becoming personalized and unstructured emphasizing, among other skills, creativity complex problem solving, flexibility, and innovation (Tsekeris, 2019). It is therefore important that certain skills, especially that of being creative, should become central in the 4IR curricula design, learning, and assessment. The notion of creativity is, however, diverse to the extent that Høffding (2011) acknowledges that it is difficult to define without being repetitive. Others like Fischer et al (2005) and Barrett (2006) give it a rather weird stereotype of a lone thinker.

The subject of creativity is, however, well debated and its association with thinking or mental visualization is apparent in most philosophical writings. Høffding (2011:54), consequently, writes that "to be creative, is to see possibility, to see something that is not yet there, to see that things could be different, or that empirical reality is not absolute". Philosophers such as Kant base creativity on the power of imagination (Gaut & Livingston, 2003). Descartes (1998) proposes that doubt and the active negation of pre-held beliefs are the hallmarks of creativity. It is seen as emerging from the 'de-absolutization' of beliefs. Others, like Edward de Bono, have tried to systemize the process by emphasizing lateral thinking and proposing different 'thinking hats' for different situations (de Bono, 2019). Their idea of creativity involves "generating new ideas, alternatives, possibilities, and new concepts". Boden (2004) stresses that creative artifacts and ideas must be new, surprising, and valuable.

Malafouris (2014) observes a limitation in research on creativity resulting from an obsession with the mental processes of the human mind. They advance that human beings are born creators of physical objects through the inherent ability to be manipulative, crafty, and give form to matter thereby producing tangible artifacts. They call this creative *thinging* –the "capacity for inventiveness that is inseparable from the capacity to affect and be affected through movement and sensation from the phenomenal qualities of the materials that surround us" (pp: 144). They argue that creative *thinging* [crafting] does not take the form of some special representation in a human mind but "emerge as part of a dynamical process of enactive discovery and material engagement that criss-crosses the boundaries of skin and skull" (pp.147). This form of creativity emphasizes making something.

Gaut and Livingston (2003) identify the duality of originality and value as the widely regarded standard of creativity. It goes without much debate that useful or 'creative-worthy' acts in the 4IR skills development should emphasize both thinking (mental acts) and thinging(creation of valuable objects). It is however worthwhile to note that computer systems are now capable of producing creative outputs that are close to human actions in artworks such as music (Sturm et al. 2019). These creative abilities of machines can be attributed to the field of artificial intelligence. Taking some of the creative and perceptual of human acts such as creative arts, as examples, it is becoming clear that artificially intelligent systems are edging closer to reaching human-like creativity levels. Perceptive and creative arts were viewed by Coulson-Thomas's (2017) as somewhat resistant to machine take over, but this is changing. Artificially intelligent systems are composing music, for example, the album 'I AM' was composed by an artificially intelligent system (Sturm et al.,2019). Systems that can recognize the emotional status of human beings are emerging (Dormehl, 2017) as well as pet bots that are, chatty, therapeutic, cuddly, and can even make eye contact (Fulmer, 2018). Similar developments are also happening in other fields such as sciences, medicine, arts, or commerce.

Creative outputs, in the sense of both thinking and thinging can, thus, no longer be confined to the human mind and actions. Granted, artificial intelligence is a creation of the human mind but its application and use create a social agency of its own that is independent of the being. There is a reason

for intrigue when the machines can now, as Fulmer (2018) puts it, independently invent, discover and revolutionize existence.

The dramatic increases in the capabilities of artificially intelligent applications in creative work create a need for a close assessment of the notion of creativity in the 4IR skills development. It is worthwhile to assess the pedagogical implication of having artificially intelligent systems that are capable of creative works or exhibiting what Ertel et al. (2017) describe as person-like behaviors in terms of intelligence. The question to consider is how to conceive creativity in a skills development context in the 4IR era of artificially intelligent systems capable of creative outputs. Hamilton-El Aquil's (2021) even ponders whether creativity is intrinsically human.

The integrative literature review approach is used, in this paper, to explore the notion of creativity in an educational context by examining how it is positioned in different pedagogical theories. The review is qualitative and non-systematic (Snyder, 2019). It focuses on the literature around the notion of creativity in the context of 4IR pedagogy by reconsidering and factoring in the abilities and capabilities embedded in artificially intelligent machines. A framework for conceptualizing creativity in the 4IR skill development context is proposed together with possible application contexts. The framework persuades that skills development in the 4IR is happening in a post-humanistic entanglement of humans and machines. Artificially intelligent technology is viewed as playing both assistive and co-creative roles with humankind in the 4IR.

This paper differs from mainstream research on creativity in skills development in that it does not attempt to propose another prescriptive tool on how to be creative like what others like de Bono (2019) did with the thinking hats. It does not join the philosophical debate on whether creativity is related to imagination, whether the process is rational or whether it is a virtue as what (Gaut, 2010) did. It analyses the notion of creativity metaphysically by exploring and proposing new and nuanced ways of conceiving it when teaching in an era dominated by 'more capable machines' whose roles have become central and gone beyond being mere assistive gadgets

2 Creativity and pedagogy

A viable starting point to understanding the notion of creativity in a skills development context is to examine how it is construed in the different theories of education - the mechanisms by which academic knowledge-creation is systemized and implemented. As indicated by Edwards-Schachter et al. (2015), the understanding of creativity and innovation varies depending on the underpinning philosophies driving a particular curriculum system.

Behaviourism, an early educational philosophy of education, emphasizes the creation of observable changes in learners' behavioural actions in response to environmental stimuli as the cornerstone of teaching and learning processes (Kay & Kibble, 2016). Behaviourist learning is criticized for not promoting creativity as it bases learning actions on repeating and reinforcing established patterns as well the selection of correct responses from a predefined set of facts (Rawat, Qazi, Hamid, 2012). Consequently, as confirmed by Ertmer and Newby (2013), behaviourism, does not promote the acquisition of higher-level thinking skills needed for deep synthesis. Another early theory of learning, cognitivism premises learning on mental processes. It emphasizes "cognitive processes such as thinking, problem-solving, language, concept formation, and information processing" (Ertmer & Newby, 2013:50). Creativity in the cognitivist learning paradigm is seen as a mental act thereby emphasizing actions such as building and reorganizing mental models as well as how these are imposed on problem-solving processes (Mayer, 1989). Even the social constructivist paradigm, which is seen as an improved successor to early educational theories, advances that knowledge is created through human activities as meaning is a social construct emerging from interactions with other beings (Fosnot, 2013). Constructivist pedagogy persuades that creativity emerges from complex social and cultural teachings.

Chandler and Teckchandani (2015) indicate that to be creative, in the constructivist sense, is to be an independent thinker, a critic, and a problems solver.

Pragmatic educationist, John Dewey, however, rejected that learning could be a 'mind-only' thing as it may be perceived (Miettinen, 2000). The formation of proper judgments (critical reflection) is important in Dewey's approach to creative thinking (Rawat, Qazi, Hamid, 2012). Dewey in Miettinen (2000), in addition, emphasizes that education and learning are not passive but involve using hands, feet, and tools. Even Lave and Wenger (1991:52), when commenting on the notion of understanding, a presumably mind thing, elaborate that it involves doing (*read thinging*) because active participation "dissolves dichotomies between cerebral and embodied activity, between contemplation and involvement, between abstraction and experience: persons, actions and the world are implicated in all thought, speech, knowing and learning". If learning could not be a 'mind only' thing in Dewey's thinking then creativity can as well be seen as an active process. Efforts to wean knowledge-creation from the 'mind-centric' approaches continue in later pedagogical thinking such as in the work of Siemens (2004). Their connectivist learning proposition, designed in the technological era (read 4IR), doubts that *all* learning occurs solely 'inside' a person. According to Siemens (2004), knowledge resides in both beings and networked artifacts including appliances and machines. Knowledge creation, understanding, or even creativity may as well be construed as the ability to create, use or manage the interconnected labyrinth of beings, artifacts, and machines in the connectivist learning approach.

Dewey's inclusion of body parts such as hands, and feet, as well as apparatus and appliances (devices) in knowledge creation as well as the emergence of philosophical thinking that removes the being from the centre of the social, create a wider perspective for contemplating the notion of creativity in the 4IR skills development context. There is a basis for tackling Hamilton-El Aquil's (2021) question of whether creativity is intrinsically human. The next section proposes a new approach to thinking about the notion of creativity when developing skills in the 4IR of machines and artificial intelligence

3 The 4IR Skills Development Creativity Wheel

Artificially intelligent systems are ubiquitous in many facets of life in the 4IR and education is not an exception. Systems capable of creating artworks, music or sophisticated architectural designs will soon rather than later invade the learning space. These systems are unlike most learning technologies such as the mathematical calculator, Learning Management Systems, or the internet whose role is mostly assistive. Artificially intelligent systems exhibit creative abilities and can produce outputs that are close to human creativity. As an example, how would the assessor treat an artwork from a student where artificially intelligent technology has been used in producing the artwork? Would this be the case of a cheat or a creative techno-genius? The easier option would be to resist the use of these creative technologies in pedagogy for as long as is possible. The sustainable option would be to embrace artificial intelligence systems in pedagogy and to seek accommodative frameworks for understanding creativity in the 4IR era dominated by creative machines as proposed in the next paragraphs.

A critical analysis of the works of philosophers Kant, Descartes, and traditional pedagogy (behaviorism, cognitivism, and constructivism) primes the mind as the initiator of all that is creative, original, and valuable. Dewey's pragmatism, Malafouris' (2014) creative thinging (making), and connectivist positions on pedagogy suggest an entanglement of the human creative mind, bodily parts, and artifacts (artificially intelligent systems) into an inseparable web of existence. Unpacking this entanglement could be what lies at the core of understanding what is needed to be creative in the 4IR skills development. Early scholar and pragmatist Dewey bound the mind, the body, and devices (apparatus and artifacts) in the problem-solving process.

Artificially intelligent systems are now not only ubiquitous but have self-agency; the capability to conduct their own intelligent and creative work. Artificial intelligence systems can as well be

considered as additional *thought agents* available to humanity for creative purposes. Creativity in the 4IR skills development context should, thus, involve the use of the mind (thinking), creating (*thinging*), and artificially intelligent technologies. It is, therefore, proposed that 4IR skills development should be pivoted (fulcrum denoting centrality) on creative problem-solving that is supported (enabled) by (but not limited to) *thinking, thinging and artificial intelligence*. The visual metaphor of a wheel (ancient machine) is used to crudely represent this conceptualization of creativity in the 4IR skills development as illustrated in Figure 1.

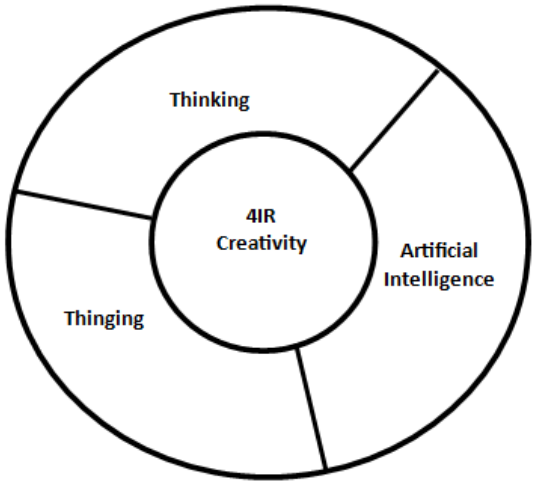

Figure 1: The 4IR Skills Development Creativity Wheel

How do the three aspects hold it together to inform creative actions in the 4IR skills development? The wheel is a metaphoric and symbolic denotation of the 4IR societal progress resulting from the creativity that is driven by thinking, '*thinging'* and artificial intelligence. It is easy to tie thinking and *thinging* together because of their conceptual association with human actions but putting artificial intelligence at the same level is, understandably, problematic. First, thinking and *thinging* are both human acts while artificial intelligence is an artifact. Second, artificial intelligence is a product of human thinking and *thinging* thus reinforcing the widely accepted superordinate-subordinate relationship between human capabilities and machines - artificial intelligence in this instance. The Actor-Network Theory, conceived in the materialistic philosophy, helps explain the somewhat difficult characterization of the 4IR skills development creativity wheel depicted in Figure1.

Using the Actor-Network Theory, as a referential theory, the proposed 4IR skills development creativity wheel should be conceived as an assemblage of constituent elements as opposed to a connection of related parts. A helpful explanation of this assemblage is Kamp's (2019) explanation of the social in an Actor-Network. They argue that the social should be seen as an assorted and constructed collection of humans and non-humans that does not privilege humans above other actants. Latour (1996:370) indicates that what binds such networks is not "concentration, purity, and unity", but "dissemination, heterogeneity and the careful plaiting of weak ties". Consequently, the emphasis of what is proposed in Figure 1 is not on the relationship between thinking, *thinging* and artificial intelligence but a realisation that their presence creates a new social dynamic that is altering the face of how to be creative in the 4IR era. Post-humanistic theories also confirm this decentring of the human from the 'social' by suggesting that existence is now distributed in both social and material networks (Frauenberger, 2020). Putting human actions such as thinking and thinging at par with artifacts such as artificial intelligence as done in Figure 1 is thus theoretically sustainable. Examples of how the 4IR skills development creativity wheel can be put into practice are presented in the next section.

4 The 4IR Creativity wheel in action

Viewing creativity as a process driven by thinking, thinging and artificial intelligence provides a basic framework on which 4IR skills development can be hinged. Two classical examples are suggested. Skills development programmes could be conceptualised in which curriculum designers configure learning and assessment outcomes based on the constituent components of the proposed 4IR creativity wheel. They will categorize, for example, which parts of the creative learning outcomes should emphasize thought (as in thinking), thinging (read creating, making, building) or the use of co-creative technologies such as artificial intelligence systems. The same logic can be easily cascaded to assessment tasks. This opens the door for the adoption of artificially intelligent systems in creative learning activities together with a framework guiding their role in the creative mix.

The framework also lays a foundation to help the debate around rewarding and recognizing the creative outputs of work that involve the use of assistive and creative technologies such as artificial intelligence. An analysis of such creative works based on what can be attributed to thinking, thing-ing and the work of artificially intelligent technologies lays a defensible basis for apportioning credit when considering aspects such as rewards, recognition, and copyrights.

There are two probable misconceptions on the framework that should be addressed. Firstly, the three constituent parts of the 4IR creativity wheel that are advanced should not be seen as exhaustive. These are the barest minimum that have been unearthed at this juncture to sustain a persuasion for a move away from traditional and stereotypical thinking about creativity. Secondly, there is also no 'proportionality' implied in the size of each segment attributed to thinking, thinging, and artificial intelligence in the creativity wheel in Figure 1. It is, also, pertinent to observe that the proposed framework is very crude in its current state. It only persuades a rethinking of the basis on which creativity is viewed in literature by drawing attention to creative abilities embedded in artificially intelligent devices.

5 Conclusion and further opportunities

The Actor-Network Theory was used to design a framework on which creativity in the 4IR skills development could be hinged. The 4IR creativity wheel considers that 4IR skills development is happening in times dominated by technologies that have gone beyond being merely assistive but possessing some creative abilities. A reconfiguration of what it means to be creative becomes necessary to include creative technologies. The aspects that should drive creativity in the 4IR are the human thought-capacity, their manipulative and crafting ability (thinging) as well as capabilities inherent in artificially intelligent technologies.

There are implications of the proposed framework for skills development in the 4IR era. Firstly, the ubiquity of independently capable and creative technologies should be a cause for consideration to educators when designing both learning outcomes and most importantly assessments. Unlike the calculator or the word processor and the computer whose assistive role in pedagogy can be ascertained, artificially intelligent systems exhibit a self-agency that need careful consideration when teaching and assessing.

Follow-up research is recommended to flesh up the ideas advanced in the 4IR creativity framework. A good starting point would be to design curricular and learning tasks in a specified skills development programme based on the creativity wheel where its applicability and usefulness could be evaluated. The long-term research trajectory should be to move 4IR skills development programmes to philosophies that are more amenable to what Frauenberger (2020) considered the decentred social. Post-humanistic schools of thought that advance that the human is part of and not the centre of the universe can provide guidelines. One such attempt is Siemens' (2005) connectivism proposition on learning which realizes

that knowledge exists in nodes within and out of human brains including cyber repositories and connections such as the internet.

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