

Infusing Creativity and Technology in 21st Century Education: A Systemic View for Change

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ABSTRACT

In this article, we explore creativity alongside educational technology, as fundamental constructs of 21st century education. Creativity has become increasingly important, as one of the most important and noted skills for success in the 21st century. We offer a definition of creativity; and draw upon a systems model of creativity, to suggest creativity emerges and exists within a system, rather than only at the level of individual processes. We suggest that effective infusion of creativity and technology in education must be considered in a three-fold systemic manner: at the levels of teacher education, assessment and educational policy. We provide research and practical implications with broad recommendations across these three areas, to build discourse around infusion of creative thinking and technology in 21st century educational systems.

Keywords

Creativity, Technology, Teacher Education, Teacher Professional Development, TPACK, Policy, Assessment

Introduction

In this article, we explore creativity alongside educational technology, for 21st century education. Creativity has seen heightened discussion in fields such as psychology and education (Sternberg, 2000; Sweller, 2009), and in popular interest in broader culture as well. Lewis (2008) noted that creativity is a coveted quality of thinking often an important aspect of innovation and change. There has also been increasing educational research to support the importance of creativity in fields of thinking and learning (Henriksen & Mishra, 2015; Robinson, 2011; Williams, 2002).

Much of the research on creativity has focused on individual creativity, or psychological, psychometric or personality approaches. There has been comparatively little research on creativity in classrooms (DeSouza Fleith, 2000). The field of education must consider the applications and rationale of creative educational practice and policy, especially for 21st century, technology-rich contexts. New technologies have altered teaching and learning rapidly, with innovations and affordances for creating and sharing ideas and content. We must consider the development and impact of learning technology not in isolation, but rather alongside opportunities for creative education.

We begin by considering the global context for an emphasis on creativity, then describe the foundations for creativity in society and in education, alongside educational technology. This emphasis on creativity and its curricular integration requires forethought and planning. In drawing on a systems model for creativity in broader culture, we suggest that there are three threads of importance for creative education with technology: teacher education, assessment, and educational policy. In this three-pronged approach, we describe how each has a role in building appropriate educational contexts to meet the needs of 21st century learners and teachers.

Context for change

The rapid pace of new technology development has presented a challenge for classroom technology integration (Zhao, 2012). Creativity is deeply connected to issues of technology integration, so these issues of creativity and technology can be considered in tandem.

While new technologies and discoveries have been a constant through human history, digital technologies rapidly scale up the technological growth. We have seen an incredible flowering of creativity and innovation fuelled by the capabilities of such technologies. From Google to Facebook, from cloud computing to YouTube channels, digitality has altered how we live, work and connect with each other (Mishra & Henriksen, 2013). Technological change is

driven by human creativity, and in turn provides new contexts and tools for creative output. Given this reciprocal relationship between creativity and technology we suggest that teaching and learning must emphasize their connection (Henriksen, Hoelting, & The Deep-Play Research Group, 2016). It is important to explore the relationship between these constructs across varied, global educational contexts.

This is a challenge, because even as standalone issues, both have confounded attempts at common, effective educational approaches. Yet a better understanding is vital. Creative thinking is essential for 21st century success, as societal problems become more interdependent, global and complex. Daniel Pink (2005) has stated that the skills that were important in the past (the popularly termed “left-brain” skills) are still important but not enough. He suggests that “the ‘right brain’ qualities of inventiveness, empathy, joyfulness, and meaning—increasingly will determine who flourishes and who flounders (Pink, 2015, p. 3).”

While there has been increased interest around creativity in education, this has not always translated into practice. Traditional “drill and kill” approaches or standards-based teaching have often squeezed creativity out of the curriculum or areas of policy and assessment (Giroux & Schmidt, 2004). For all its importance, creativity is a concept that has not been well understood, framed, or defined. Education needs a frame to help students and teachers develop creative thinking skills that span disciplines, and use technology tools for creative solutions and outcomes. In the next section, we consider some key literature on creativity, and situate our thinking in a definition of “creativity.”

Examining creativity in its foundations

Research has shown intellectual, educational, and talent-building advantages associated with creativity throughout life (Blicbau & Steiner, 1998). Educational psychologists have noted connections between creativity and other significant areas including: life success, leadership in the workplace, psychological functioning, and intellectual/emotional growth (Williams, 2002).

Sternberg (1999) noted that creativity is available to everyone, but is most prevalent in young children. As he states, creativity “may be harder to find in older children and adults because their creative potential has been suppressed by a society that encourages intellectual conformity” (p. 93). Robinson (2011) also suggested that conventional approaches tend to crush students’ natural inclinations toward creative and divergent thinking. Sternberg (2006) has stated that, “When students are taught in a way that fits how they think, they do better in school. Children with creative or practical abilities, who are almost never taught or assessed in a way that matches their pattern of abilities, may be at a disadvantage in course after course, year after year” (p. 94).

The role of the teachers and classroom settings is an important influence upon student beliefs and development of their own creativity. Amabile (1996) asserts that when all variables that influence creative development are considered, most factors are classroom-related. Creative teachers show a willingness to try new things, give real-world assignments, and use cross-disciplinary approaches (Henriksen & Mishra, 2015). As a result, their students tend to be enthusiastic and engaged (Kiely, 1998), building the skills and habits of mind for success in problem solving and applying knowledge (Zhao, 2012).

Despite its importance, theorists have struggled to find common ground in a concrete definition of the term (Sternberg, 1999). Yet having a definition is essential to the instantiation of an idea—in order to apply a working shared understanding of its themes.

A definition of creativity

Creativity can be viewed as a process and/or a product, and is generally thought of as the production of useful solutions to problems, or novel and effective ideas (Amabile, 1996). An idea that has novelty, but lacks in value or effectiveness to other people, cannot be considered “creative” (Cropley, 2003).

Two factors in most discussions of creativity are “novelty” (or newness, originality, freshness, uniqueness, etc.) and “effectiveness” (or value, usefulness, quality, etc.) (Sternberg, 2006). But while these two recur in many definitions for creativity, some scholars have called for the inclusion of a subtler, third component.

Sternberg and O’Hara (1999) argued that “task appropriateness” should be added to the definition, speaking to the contextuality in creative work. Based on this, creativity lies in the ability to create ideas or works that are “novel, high in quality, and task appropriate” (p. 255). This suggests that creative work is dependent on context, because it is assigned value in relation to the domain it is created within. Mishra, and Henriksen (2013) note that an innovative mathematical proof or a unique beautiful painting are incredible different things, yet they are both “creative.” They both have an aesthetic context that goes beyond novelty and utility. Mishra and Koehler (2008) describe this aesthetic sensibility in context as “wholeness,” which is a third, crucial component of creativity. Thus they offer a “NEW” (novel, effective, whole) definition of creativity (Mishra & Koehler, 2008; Mishra, & Henriksen, 2013).

Here, we suggest this NEW definition for educational contexts, and as our definition in this article. We define creativity as both the oft-noted “novel,” and “effective,” in addition to the subtler component of “wholeness” (or context, important to education). Recent scholarship has focused on this definition of creativity, along with attempts to develop rubrics to measure creative student output (Henriksen, Mishra, & Mehta, 2015; Mishra, Henriksen & Mehta, 2015).

Going beyond “what is creativity” to “where is creativity”

While our definition of NEW (novel, effective, and whole) is supported by research (Henriksen, Mishra, & Mehta, 2015), we acknowledge that any shared definition of a subjective concept is challenging. So we propose that we must also go beyond defining “what is creativity?” To ask, “where is creativity?” Asking this helps us locate creativity in specific realms that impact practice, a key point for the field of education.

In this we draw upon Csikszentmihalyi’s (1997) discourse about: “where is creativity?” Csikszentmihalyi moves beyond typical definitions to emphasize a systems model of creativity, in which creative production is an interaction of systemic elements.

To understand creativity as a complex phenomenon “we need to abandon the Ptolemaic view of creativity, in which the person is at the center of everything, for a more Copernican model in which the person is part of a system of mutual influences and information” (Csikszentmihalyi & Csikszentmihalyi, 1988, p. 336). We must consider how creativity arises from a dynamic interaction of “a system composed of three elements: a culture that contains symbolic rules, a person who brings novelty into the domain, and a field of experts who recognize and validate the innovation” (Csikszentmihalyi, 1997, p. 6).

Csikszentmihalyi (1997) asserts that creativity lies in the interaction of the *individual*, the *domain*, and the *field*. This system is where creative work emerges (as represented in the diagram below) and functions among these three arenas. Creativity is developed and disseminated based on the judgments and interactions of members of those levels. As the diagram indicates, the Individual, the Field and the Domain work together reciprocally to decide if something is creative (i.e., novel, effective & whole).

At the level of the *individual*, individual people (or groups/teams) produce creative work, ideas, art, or new discovery. But creativity does not happen there alone. Creativity is affected at the level of *domains*, which are areas of specialized knowledge (e.g., mathematics, biology, physics, art, law, and more). A domain is the symbol system that an individual (or group) working in an area uses. It includes the tools, rules, conventions, knowledge, norms, and systems of techniques, codes, or symbols that help a person create or discover new things in the domain. At the level of the *field*, creative work is disseminated to an audience to make impact. The field is a collection of “experts,” communities of practice, or people with the knowledge capital and clout to make judgments influence the domain (about what is valuable work, at the cultural or social level) (Csikszentmihalyi, 1997).

Each of these three components – person, field and domain – exerts and receives influence from the others. Each component is a necessary factor in creativity (and even expertise) but not sufficient in itself to produce impact or valuable novelty. Creativity exists as a dynamic process emerging through a system of interactions.

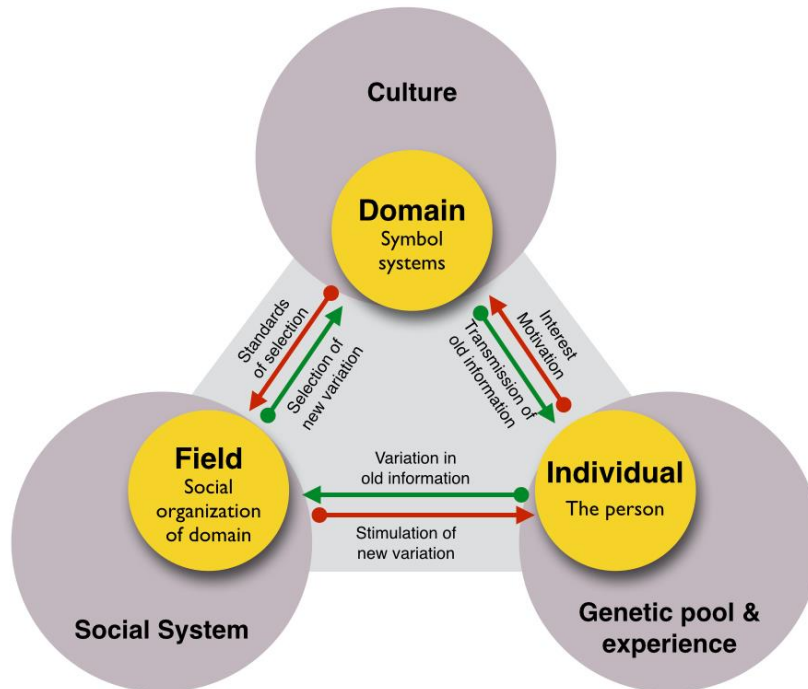


Figure 1. Individual – Field – Domain and their interactions to determine *Where is Creativity?* (Based on Csikszentmihalyi, 1997)

In any systemic interaction we can see how creativity has multiple entry points within the system. So, this informs our considerations of how we think about the systemic aspects of creativity in education. Given this, we must consider *how* and *where* it might be infused through entry points. In identifying categories of stakeholders that play a role in this process, we decide where to place our emphasis. In later sections, we elaborate on how this type of systems-thinking model might be defined in education. We suggest creativity must become systemic, at the levels of *teacher education, assessment, and educational policy*.

We must note that technology plays an important role in every aspect of this transaction among the domain, the individual and the field. It impacts construction of knowledge, its sharing with a wider community and its acceptance by the field. Therefore, we explore this relationship between creativity and technology next.

Creativity and technology in education

Creative teaching alone is a complex and open-ended arena. Incorporating effective uses of technology for teaching is also complex on its own terms. So things become more complex when these two intersect, as they must in 21st century classrooms. Mishra, Koehler, and Henriksen (2011) have argued that the best uses of educational technology must be grounded in a creative mindset that embraces openness for the new and intellectual risk-taking. This is a tremendous challenge for any teacher, but especially new teachers. It has not been addressed in great detail by teacher education, professional development, or educational policy.

Contemporary technologies often bring new possibilities for people to be creative. In classroom terms teachers must understand the range of ways in which technology can present content creatively, and see how this intersects with different pedagogies. Since technologies emerge and shift continuously, a tool-based focus is akin to a moving target. Creative real-world approaches to teaching might allow us to also consider how technology helps us view and learn content in original or compelling ways. It allows us to create content, rather than summarize and repeat it.

TPACK (Mishra & Koehler, 2006) has become a central framework for using technology well in the classroom. It focuses on knowledge types for effective teaching with technologies (from chalkboards to smart boards, pencils to Pixlr). The TPACK framework suggest that that teachers have a specialized brand of knowledge for using classroom

technology, involving an integrated combination of Technological, Pedagogical, and Content knowledge. While TPACK framework has received a significant level of scholarly and theoretical attention (Herring, Koehler & Mishra, 2016), it has been argued that the framework overall is neutral with regard to the goals of teaching. As Mishra, Koehler and Henriksen (2011) write:

It is also important to note that the TPACK framework offers no specific directives about *what* content to teach (science or music), *which* pedagogical approaches are useful (didactic or constructivist), and *what* kinds of technologies to use in teaching (digital or analog). Thus given the changing world we live in, it becomes critical for us to ask ourselves what it is that today's students need to know in order to succeed... Once we identify these larger purposes and goals, the TPACK framework helps us consider *how* to achieve them... (p. 24).

Focusing on the affordances of tools, and how tools can serve the content in novel and effective ways, helps us use creativity as a driver for good teaching with technology. One of the key affordances of digital technologies is that content or knowledge can be created, shared, and discovered much more quickly and easily (Henriksen et al., 2016).

With digital media contributing to globalization and diversification of ideas and content, there has been a rethinking of how we communicate and share ideas, art, culture, and other forms of content. New technology has much to offer to the world of creative sharing—as seen in internet crowd-sourcing of data or ideas, new applications for content development, creating unique or remixed work, sharing video/audio/images/text across global contexts, and websites that allow diverse creators to share content (for example, YouTube, Sound Cloud, Vimeo, to name a few) (Henriksen, et al., 2016). This explosion in technologies for content sharing and development is transforming how culture, art, and knowledge emerge within disciplines.

Contemporary digital and networking technologies can play a significant role in the systems view of creativity we presented earlier. The field, the domain, the individual and their interconnections are transformed by content creation and sharing technologies. For instance, an individual can sidestep the gatekeepers of the field and connect with an audience directly. Thus the gate-keeping function now shifts from the members of the field to the audience. Moreover, the content audience can speak back to the individual creator. A good example of this is the YouTube channel, Veritasium, created by Derek Muller. Muller's channel focuses on physics, and the choice of topics is often driven by questions sent in by his audience—allowing learners all over the world interact directly with science ideas and each other via his site. Individuals can also follow their interests within a domain more promptly and easily – given the wide access to resources and information, and tools to create new knowledge/content. Thus we see the rise of YouTube superstars, individuals who have sidestepped standard approaches to creative success. This suggests a possible reconfiguration of the standard systems view of identifying creativity.

Much of our discussion here focuses on creativity “in the wild,” i.e., creativity in the broader world. This is different from creativity in educational contexts. We suggest there are two key aspects to the role of technology and creativity in the classroom. The first is that educators must be creative in devising new ways of thinking about technology, particularly for teaching specific content. Most digital tools (be it Facebook or a smart-phone or any other tool) have usually not been designed for educational purposes. It becomes an opportunity for the teacher to creatively repurpose existing tools for educational purposes (Koehler et al., 2011). Second, it is also clear that technologies afford new ways of constructing, representing, communicating, and sharing knowledge, providing opportunities for creative output by and between students that were not possible before.

These two approaches complement and support each other. An example of the first approach would be when teachers use tools (such as Facebook or Twitter) not designed for education in creative ways in the classroom. While an example of the second would be the opportunities that tools such as VoiceThread allow, for students to engage in creative multi-modal writing. Within this new context, there is a reciprocal relationship between creativity and digital technologies. Here we mean that technologies allow for new and creative pedagogical practices, but also that educators must develop a creative mindset to teaching and learning. Only then can they fully exploit the potential of these new technologies. Of course the idea of TPACK is key—in that teachers need to always ask themselves how these new creative use of tools fits with the content to be covered and their pedagogical approaches.

It is important to note the significance of teacher beliefs about creativity and technology. There is research indicating that teacher beliefs about subject matter, learning, teaching and technology influence the way they approach practice (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Kim, Kim, Lee, Spector, & DeMeester, 2013;

Richardson, 1996). As Borko and Putnam (1995, p. 37) write, “to understand teaching, we must study teachers’ knowledge systems; their thoughts, judgments, and decisions; the relationships between teachers’ knowledge systems and their cognitions; and how these cognitions are translated into action.”

The reciprocal relationship between creativity and new technologies has implications for (a) teacher education and professional development; (b) for how we evaluate student learning and output; and finally, (c) for policies we enact to support teachers and students in this arena. There are many ways to categorize the systemic elements of creativity in education. But for practicality and clarity, we suggest these are the core areas that must be considered and we look at each in greater detail below.

Three stands of influence for approaching creativity in 21st century education

Our goal in this paper is to lay out a broad plan for action. We do not provide this in micro-detail because to do so would be challenging (if not impossible), given the range of settings and variables in education. But we do wish to introduce the idea that each of these three arenas of teacher education, assessment and policy are crucial to moving these ideas forward. Specifically, teacher education focused on creativity is necessary for creativity to be infused into classrooms. Teacher training must support repurposing of technologies in the classroom and teaching approaches that creatively engage students with content. However, creative student work must also be assessed—requiring an emphasis on the assessment of creative work. Finally, none of this is possible if we do not focus on the broader policy goals of integrating technology and creativity across the policy framework of education. Thus we argue that a focus on these three areas is the first step towards locating creativity within educational systems.

Teacher education

A teacher’s pedagogy is often a primary driver of how students develop and learn. Teachers who model creativity tend to fluidly enhance, support and develop the tendency in their own students (Amabile, Conti, Coon, Lazenby, & Herron, 1996). We must build teaching dispositions that take advantage of the affordances of new tools for learning and thinking creatively, in ways not possible without new technologies (Ertmer et al., 2012). But effective teaching is difficult in itself, even without the added elements of creative and technology-savvy practices. How do we support the development of creative pedagogy, along with effective use of classroom technology, to support the 21st century teacher and student?

Teacher education programs are often the core driver of how new teachers see the profession, how they interact with students and develop their classroom practices and repertoire. Therefore, it becomes important that we see teacher education as a key site in developing a creative mindset and practices that encourage the use of new technologies creatively in the classroom. Yet the role of creativity and technology in teacher education is rarely clear, varying at the school/program level. It is essential to build a platform for teacher education programs that addresses creative, technology-rich approaches and pedagogies. In brief, the research and scholarship in this area suggests the following key recommendations.

Teacher education / teacher professional development recommendations

- *Develop Teacher Education curriculum that integrates technology and creativity across the program*
Current teacher education curricula may give some emphasis to teaching creatively with technology – though even there it appears spotty at best. The other aspect that of teaching to enhance creativity in students, and to explore the affordances of technology to do so, has received even less attention. Integration of ideas related to creativity and technology need to be across the program and curriculum. Research has shown that highly creative teachers tend to engage in a variety of creative pursuits that they draw into their teaching practice (Henriksen & Mishra, 2015). Teacher education students could be encouraged to actively spend time in creative interests, and incorporate these into lessons and activities through technology. This might include coursework that specifically asks new teachers to “play” with approaches to using technology in the curriculum in creative lessons on content. Opportunities to engage in lesson planning focused on real-world, cross-curricular and novel approaches to content and technology (TPACK) would help build creative teaching skills, as a part of a teacher

education curriculum. Examples of such practices can be found in the special issue devoted to teacher education, creativity and technology (Henriksen & Mishra, 2015), and in Koehler et al. (2011).

- *Specific course / programs focusing on creativity and technology*
Even as we seek to suffuse a “creativity mindset” across programs, we see the need for specific courses that target creativity and technology and their use in the classroom teaching/learning context. This includes more theoretical knowledge of creativity into teacher education curricula for pre-service teachers, particularly in emphasizing the relationship between creativity and student achievement or teacher effectiveness and impact (DeSouza Fleith, 2000; Henriksen & Mishra, 2015). Other researchers have highlighted the ways that TPACK can be used as the basis of creative approaches to technology integration (Koehler et al., 2011). A theoretical understanding of creativity is something that should connect to practical applications. Teacher education students must have the opportunity to consider how creativity works in their own lives and practices, particular with regard to technology and tools for teaching. See Henriksen and Mishra (2015), and Koehler et al. (2011) for examples.
- *Identify / use a framework that connects creativity and technology to curriculum guidelines*
Curriculum guidelines are overarching structures that determine how specific curricula are designed. It is important that the dual-goals of teaching creatively with technology, and teaching for enhancing creativity with technology, be incorporated in these guidelines. The use of theoretical frameworks (such as the systems model of creativity or TPACK) give cohesion to any research study or paradigm. Without a good framework guiding the work, it is hard to move beyond ad-hoc ideas and examples. While frameworks currently exist for creative education, or for technology infusion in education, it is difficult to find a framework that integrates the constructs. Developing such a framework would guide teacher education programs on a path that blends these ideas into their curricula.

Assessment

Creativity, due to its open-ended nature, is difficult to evaluate and assess. However, if creativity is to become a part of the educational process, developing a range of assessments is essential. The arena of assessment of creativity is rife with multiple challenges, which tend to present as dichotomous tensions. We see these tensions as inherent and not ones that can be wished away. As educators we have to contend with these dichotomies, and find a resolution or compromise that works in our specific context. We list a few of these tensions below.

- **Psychometric vs. Behavioral:** Most creativity research has focused on identifying psychometric characteristics of creative individuals (such as affinity for risk-taking, cognitive flexibility, etc.). At the other extreme are behavioral measures of creativity (such as the alternative uses test, where participants are asked to come up with as many alternative uses for a random object).
- **Process vs. Product:** This distinction is important in the classroom where the teacher may focus learning processes for creative solutions (sometime irrespective of whether the final result was judged creative or not) OR may focus on the output of the creative activity. Most of the current discourse on assessment has emphasized the process aspect, though there are a few approaches to considering the final product developed by students. A product is concrete and more amenable to evaluation, but process may be more important to teachers since it respects the whole learner (process may be idiosyncratic and playful, which also brings up another challenge). For example, an ICT approach tends to focus on the final output or product, compared to the art teacher concerned with process. In considering both creativity and technology, assessment has to consider how to navigate between and consider both product and process, for effective, creative uses of classroom technology.
- **Individual vs. Group:** This is particularly important in contexts where teachers give students open-ended, group projects. These projects are more authentic (in being similar to actual work-place situations) but prevent the easy assessment of the individual contribution, which has typically been the mainstay of assessment in schools. In other words, how do we get students to engage in the kinds of collaborative and open-ended products that support creativity, while also assessing their individual performance?

- Domain general vs. domain specific: This is an ongoing problem and dispute among most creativity researchers. Evaluation becomes more challenging unless we start from a place of solid agreement on whether creativity is located specifically within domains, or whether it is a more general and extendable thing.

The overwhelming theme of creativity and assessment revolves around the challenge of navigating tensions in evaluating and assessing creativity. It is important that we not focus on just one approach towards assessment but explore a range of alternative assessment formats that consider how creativity and technology intersect. These allow for the dynamic, flexible, application of idea across learning contexts.

Assessment recommendations

- *Recognize that assessment of creativity (with or without technology) exists within a range of tensions/dilemmas*
Issues related to the assessment of creativity have a range of dimensions (individual – group, process – product, domain general – domain specific etc.). These are not problems to be solved, but essential tensions to be resolved in a context sensitive manner. This is important when we consider technology-driven activities and assignments, where often the mere inclusion of technology is seen as being creative. Clearly this is a far more complex problem, where the role of technology needs to be better understood and articulated so that creative teaching, and teaching for creativity, (using ICTs) can be better understood.
- *Use alternative forms of assessment – triangulation through technologically sophisticated, dynamic and flexible approaches*
It is essential that we explore a range of different and alternative forms of assessments (i.e., open ended versus more constrained tasks) to allow for the dynamic, flexible, triangulation of the construct as it plays out in different learning contexts. Technology can play an important role in terms of allowing teachers and learners to both easily construct creative artifacts. However evaluating these artifacts (and the process that led to their construction) is complex. It requires evaluating the artifacts (or the process) through multiple assessment techniques (formal and informal; process and product; formative and normative).
- *Evidence based research on creativity and technology from the classroom*
Finally, there is clearly need for research connected to these different learning contexts where creativity and technology co-exist. These contexts differ in a range of dimensions (e.g., formal–informal; disciplinary–transdisciplinary—multi-disciplinary). This requires a new form of research, that both honors the complexities of practice as well as the broader goals and themes of learning and creativity, and the role of technology in the process. Only through such research can we offer sound, data-driven guidelines for future educators, scholars and researchers.

Educational policy

Creativity can be learned, but since it is a thinking skill it can only be “learned by doing” or as “learning in action.” Creativity involves approaches to thinking rather than a set body of knowledge that can be taught. However, we can reinforce and support sustained creativity as a “habit of the mind.” However, this also means that the education system and educators must recognize and support a sustained facilitation of creativity as a habit of the mind, and agree upon what that is and how to engage it. This can vary greatly across contexts and cultures. So essential challenges involve convincing policy makers, who often prefer clear answers and objectivity that it is important to infuse curricula with creativity, an area that does not have one “right” answer. Along these lines, policy must also begin to consider the intersection of technology with creativity, and offer guidelines for how these ideas can intersect in the classroom.

We must realize that policy texts at all levels in education (macro, meso, and micro) are predominantly indicative of practice, rather than definitive, because policies are mediated by schools, teachers and other actors in education (Ball, 1997; Wyse & Ferrari, 2014). But as we acknowledge this, policy texts are also representations of discussions on certain topics. They are important enough to be emphasized in a document, and often the basis for further curriculum development. Along with curriculum development, policy documents are often used to compare countries, regions and schools with each other. For instance, Heilmann and Korte (2010) carried out a content

analysis of national curriculum texts to study the role of creativity and innovation in compulsory education in 27 countries of the European Union. The outcomes of such studies can promote new policy texts and approaches. Wyse and Ferrari (2014) state: “The inclusion of explicit reference to creativity [in all national curricula of the EU27] is an indication that creativity is valued by policy-makers and curriculum developers” and “It is likely that creativity will have a more significant impact on pupils’ learning if the choices made to include creativity in national curricula are coherent throughout different types and sections of texts” (p 13).

An additional challenge involves how to implement something as context-driven as creativity, and as ever-changing as technology, in ways broad enough to speak to curriculum across varied settings. The variation in language and conceptualizations of creativity, the integration of creativity across disciplines, the relation between technology and creativity, and the professional development of teachers are just a few examples of complexities to consider.

Policy/Curriculum recommendations

- *Creativity and technology need to be featured in policy at all levels (macro / meso / micro)*
It is clear that creativity is complex and works across all aspects of the teaching learning process, particularly when coupled with the potentials of technology. Thus it is important that educational policy emphasize creativity across all levels: macro, meso and micro, (i.e., at the level of national policy, state or school district-wide, or individual schools and classrooms). The policy texts should in turn be incorporated into other aspects of curriculum and documentation that teachers and other stakeholders use. Policy should extend beyond the document it is built into, so that it can be operationalized and instantiated throughout the education system – particularly in documents read by teachers.
- *Creativity and technology should be embedded across the curriculum*
Creativity is not a domain by itself but a way of thinking and approach to problem solving that cuts across disciplines. Thus creativity is as important in the sciences and mathematics as it is in the arts. Technology in turn has dramatically changed the work and creative process of almost every domain of human activity. This is often forgotten and needs to be part of every policy-makers thinking. Creativity is also not a skill that is limited to few individuals. Similarly, technology is not something that is limited to a few individuals or in a few select domains. In policy and curricular documents these issues related to creativity and technology should be part for all learners, not just for the “special” or “talented” ones.
- *A greater push for research to identify models and practices*
Though creativity research has received greater attention recently, there is much we still do not know about it in formal and informal learning contexts. The addition of technology also complicates the picture. Clearly there are models and practices that work, but more systematic research is the pressing need, both in theory and practice. The use of new technologies and their reciprocal relationship with creativity needs to be studied. We need to learn more about creativity and technology and how both can be integrated in education at all levels.

Conclusion

We began by reiterating the reasons for why creativity has been receiving increased attention in education. We offer a definition of creativity as being a process of developing something that is novel, effective and whole (NEW), and suggest that it is a complex skill prevalent across domains and practices. Moreover, we argue that a productive way of thinking about creativity not only considers *what* it is but also *where* it is located. In this a systems view of creativity captures the complexities of identifying creativity. The advent of new technologies can initiate, stimulate, broaden and expand how we think about creativity systemically. New digital and networking technologies with their dual affordances of ease of creation and ease of sharing complicates the standard systems model. In a reciprocal way, technologies support creativity even as creative approaches create new ways to use (repurpose) technologies for pedagogical purposes.

Despite the increasing importance of creativity and ICT in education, neither area has had broad-based, significant impact on teaching and learning. Part of the reason for this is in the complexity of the process of integrating both in to the curriculum. The inclusion of creativity is hampered by the fact that educators have to focus on both teaching

creatively and teaching for creativity. Both of which need teacher training, new approaches to creative assessment, and broader policy frameworks that support the integration of creativity in the curriculum. We have provided broad recommendations for all three of these aspects.

These recommendations are aimed across education: teachers, scholars, curriculum designers, policymakers, and researchers. It is only when all of these different stakeholders work together, for the broader goal of integrating creativity and technology in education in a system-wide manner, that we can have hope for making a change. In this way, research, practice, and policy come together. Such an alignment is necessary, if we truly believe that creativity is important for the future of education.

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