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# Creativity and technology in teaching and learning: a literature review of the uneasy space of implementation

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## Abstract

Internationally, creativity is a widely discussed construct that is pivotal to educational practice and curriculum. It is often situated alongside technology as a key component of education futures. Despite the enthusiasm for integrating creativity with technologies in classrooms, there is a lack of common ground within and between disciplines and research about how creativity relates to technology in teaching and learning—especially in the uncertain space of classroom implementation. This article provides a critical thematic review of international literature on creativity and technology in the context of educational practice. We identify four essential domains that emerge from the literature and represent these in a conceptual model, based around: (1) Learning in regard to creativity, (2) Meanings of creativity, (3) Discourses that surround creativity, and (4) the Futures or impacts on creativity and education. Each of these clusters is contextualized in regard to emerging technologies and the developing scope of twenty-first century skills in classroom implementation. We offer conclusions and implications for research and practice.

**Keywords** Creativity · Technology · Learning · Education · Teaching · Classrooms · Literature review · International review · Model · Implementation · Implications · Creative thinking

## Introduction

Creativity cuts across disciplines and cultures as a highly coveted quality of human cognition. Beyond its foundational roots in human psychology, science, the arts and literature, it has become an established component of "twenty-first century" knowledge and skills discourses (Van Laar et al. 2019). This rising interest in creativity has occurred during a period of significant societal change due to rapid shifts and developments in technology (Collins and Halverson 2018). Technologies are altering how humans think, work, live, play and create faster than ever. It is, therefore, no surprise that this interest in

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digital technologies has emerged alongside creativity as critical to contemporary education (Mishra and Mehta 2017).

Despite this seeming alignment, research discourses around educational technology and creativity have rarely intersected. Nor has the instantiation of these ideas in actual classroom contexts been comprehensively researched. Given the importance of these constructs, the field needs a stronger understanding of how scholarship addressing creativity and technology is organized, especially related to classroom implementation. The need to connect classroom implementation to these themes is heightened by a push for fluency in creative thinking and technology skills among teachers and students (Mehta et al. 2019). Despite the development of educational policy about creativity, and research into technologies and practices aligned with creativity, instantiating these into the realities of classrooms remains a significant challenge (Hall and Thomson 2008).

Schön (1995) highlighted a schism between the world of scholarship and applied practice and described these uneasy spaces of implementation. We use the term 'uneasy spaces of implementation' to refer to the uncertain, unclear or debated contextual practices and situations in which practitioners may encounter conflicting stakeholder demands around implementing innovative practices. These complications are exacerbated when it comes to creativity, since creativity is often regarded as being subjective and contextual or, sometimes, as a distraction from the goals of 'real' learning. These tensions play out across multiple contexts and situations. For instance, while there may be a goal of building more creative learning environments in schools—this can be complicated by varying visions or definitions of creativity, or the reality where teacher evaluations focus more on raising test scores than enhancing student creativity. Consequently, these tensions lead to challenges for research, often making it difficult and even uneasy to study such fraught problems.

The problem is also partly in how researchers have approached these complex issues. The situations where practitioners live are uncertain, complex, unique and often riddled with conflicts between perspectives (Buchanan 1992). Schön (1995) notes that the "turbulent world of practice…is notoriously uncontrolled," and often characterized by ill-formed problems. Further, he writes, "in the swampy lowlands [of practice], problems are messy and confusing." In contrast, he described the world of research as being a "high, hard ground" where "manageable problems lend themselves to solution through the use of research-based theory and technique" (p. 29). This schism between theory and practice (or the high ground vs. the swamp) has long been criticized as artificially separating research from the reality of classrooms and the lived experiences of teachers and students (Levine 2007).

The solution to this, Schön argued, was the need to involve practitioners in research, or to have stronger partnerships between research and practice. This is important not just to account for the messy realities of practice within research, but also to move the conversation away from the exclusive domain of the "high, hard ground." In bringing together the "turbulent world of practice" with the so-called ivory tower, Schön believed that we might look to a "new epistemology of practice" in academia (1995, p. 29). This new epistemology of practice is notable when we observe or investigate complicated spaces within which complex constructs such as creativity and/or technology play out. That said, aligning research with the realities of practice is challenging in areas where researchers hesitate to tread (e.g. creativity is sometimes viewed as a subjective or contextually-driven construct, and considered difficult to study or measure) (Henriksen et al. 2016b).

This research-practice disconnect appears in almost all aspects of education but is more problematic when we move beyond standard contexts into the realm of higher order cognition and learning. For instance, the use of technology for rote learning is

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relatively less complicated than using technology to enhance creativity. Given these complexities, it is not surprising that scholars have not always attended to these messy or uneasy spaces of implementation. If we expect research to change practice, then more research must descend into Schön's "swampy lowlands," where ideas can be challenged by the realities of classrooms. There may be a greater need to engage more practitioners in action research or participatory research, perhaps seeking to build this new epistemology, based on practice.

In this paper, we delve into this gap through a critical thematic literature review of existing scholarship at the intersection of creativity, technology, and teaching/learning in classroom contexts. This review is transdisciplinary in nature and casts a wide net, examining scholarship with an international lens. We identify the contours of existing research in these areas and note their alignments and gaps to point to future research needs. Our goal in this paper is to understand how research addresses, or fails to address, the messy spaces of classroom implementation. While scholarship exists about how these constructs of creativity, technology, teaching, and learning can support each other—there is less clarity on how to do so (Sullivan 2017). This uncertainty is confounded by the fact that, globally, classrooms are under the push and pull of multiple divergent stakeholder perspectives.

We begin with background and context on spaces of implementation involving creativity, technology, teaching, and learning. We describe our methodology, encapsulated in a visual model to connect these constructs with the extant research literature. Our findings flow from this model, with four thematic domains that provide a structural overview of the literature. We conclude with possible implications for future research. We also acknowledge that, given the complexities of transdisciplinary literature, our work, though important, is necessarily provisional in nature.

## The context of creativity, technology and education

Creativity is a pivotal construct that is widely employed across disciplines in academic work, policy frameworks and practice (Collins 2019). There are also tentative new alignments between different understandings of creativity, as well as transdisciplinary and hybrid approaches to creativity, design, and technology (Lin 2014). What is less certain is how these new alignments and approaches relate to the uneasy space of classroom implementation.

Interest in creativity has been fueled by the affordances provided by digital technologies, including, but not limited to, massive connectivity and the creation of virtual environments with new possibilities for learning. Digitality has altered how we live, work and connect with each other. Arguably, technological change is driven by human creativity, which in turn provides new contexts and tools for creative output. Scholars have suggested that educators and researchers must better understand and emphasize this reciprocal connection (Zhao 2012).

Contemporary classrooms are uncertain, evolving and discursive spaces with complex demands and challenges (Duffy et al. 2017). These include, but are not limited to, content/pedagogical needs in national and local curriculum policy frameworks, calls to implement digital technologies, and the rhetoric to foster twenty-first century skills (Geisinge 2016). Thus, schools operate in the nexus between local demands and national and international curriculum and policy contexts which increasingly value creativity (Collins and Halverson 2018).

## Method

This review aims to bridge the gap between research, policy and practice literature about creativity, technology and classroom implementation, and to offer an organized conceptualization of this literature. In addressing the gap, a critical thematic review was deemed most appropriate. We see our work in this review as an important first step in closing this gap, yet we acknowledge that we tread warily into a diverse and shifting space of research and practice.

A critical review provides an analysis and synthesis of diverse sources, including research disciplines, methods, and even grey literature (Grant and Booth 2009). Unlike other types of reviews, a critical review moves beyond description, adopting an interpretivist stance in revealing, among other things, the contradictions, tensions, and dilemmas within extant literature (Grant and Booth 2009; Paré and Kitsiou 2016). A critical review does not seek to delimit a field of research, but rather to engage in a process of synthesis as a "boundary-breaking exercise" (Walsh and Downe 2005, p.205) which leads to new insights and "conceptual innovation" (Grant and Booth 2009, p.94). Thus, in employing a critical review methodology, we sought to identify significant and illustrative contributions to develop the conceptual richness of the synthesis and address the complexity of the concepts and their interrelationships (Grant and Booth 2009; Paré and Kitsiou 2016).

The initial search of a cross-section of international literature was conducted via the following databases: ERIC Database, Google, Google Scholar, and SemanticScholar. Given the rapid pace of technological change, we also limited the search to publications between 2005 and 2020 (some older citations only appear as discussion/reference points). Searches used combinations of variants of creativity, technology, education, teaching, learning, and classroom. The inclusion criteria were not limited to peer-reviewed literature but also included grey (e.g. policy) and practical literature if they offered competing or alternative perspectives relevant to the intersection of school practices, creativity and technology. Papers were excluded if they dealt with the key foci in peripheral ways offering little in the form of concrete takeaways.

In keeping with existing critical review methods (Grant 2019; Eliot and Hirumi 2019; Novak 2015), we expanded the search process, including back-tracking of references, and the inclusion of more recent papers that cite the original publications or appeal to known authorities in the field. The need for expanding searches in this manner is a recognized consequence of trying to bring together diverse schools of thought (Walsh and Downe 2005). Publications were added to our corpus of literature if they enhanced the conceptual understanding, seeking theoretical saturation (Charmaz 2003) rather than comprehensive coverage.

The data analysis followed a thematic analysis approach, which included interconnecting both inductive and deductive processes. Accordingly, we familiarized ourselves with the data, which were the key concepts or findings in varied studies or papers (Moustakas 1994). Through meaning-making in shared discussions, the emerging findings were organized thematically (Braun and Clarke 2006). After three iterations of reviewing, analyzing and making meaning of the results, we formed four key domains, which relate to creativity, technology and education (Fig. 1).

A further iterative step was undertaken, in the vein of Grant (2019), in which we sought to test the scope of this categorization scheme, the breadth of the literature search and the conceptual robustness of the model. We presented the concept of these four domains at SITE 2018 (Henriksen et al. 2018). Feedback resulted in a further process of thematic
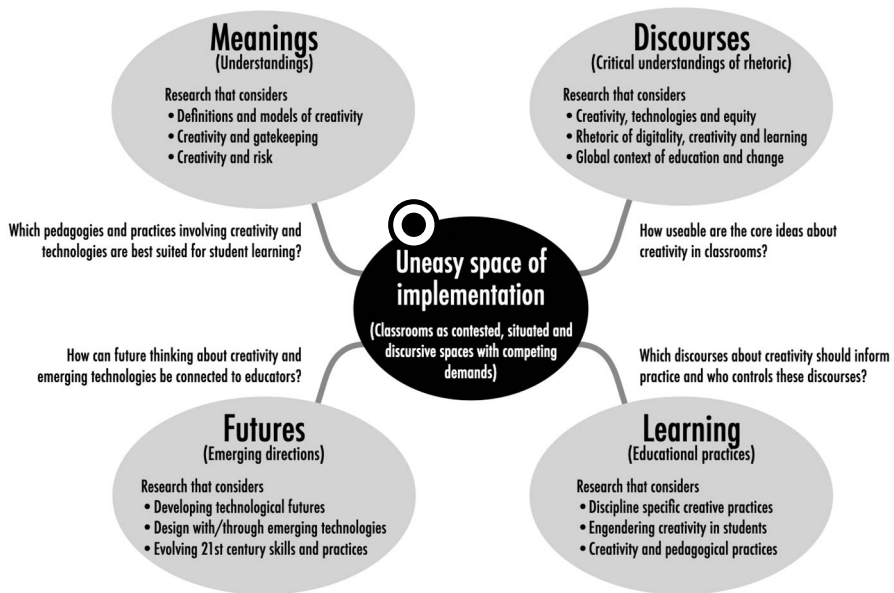
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**Meanings**
(Understandings)

Research that considers
• Definitions and models of creativity
• Creativity and gatekeeping
• Creativity and risk

**Discourses**
(Critical understandings of rhetoric)

Research that considers
• Creativity, technologies and equity
• Rhetoric of digitality, creativity and learning
• Global context of education and change

Which pedagogies and practices involving creativity and technologies are best suited for student learning?

How useable are the core ideas about creativity in classrooms?

**Uneasy space of implementation**
(Classrooms as contested, situated and discursive spaces with competing demands)

How can future thinking about creativity and emerging technologies be connected to educators?

Which discourses about creativity should inform practice and who controls these discourses?

**Futures**
(Emerging directions)

Research that considers
• Developing technological futures
• Design with/through emerging technologies
• Evolving 21st century skills and practices

**Learning**
(Educational practices)

Research that considers
• Discipline specific creative practices
• Engendering creativity in students
• Creativity and pedagogical practices

**Fig. 1** Domains of creativity and education

abstraction, which resulted in greater clarification of the four overarching thematic categories (Learning, Meanings, Discourses and Futures).

## Findings

In this section we present our findings built around four key domains formed from our inductive and deductive engagement with the literature:

### Meanings

The set of understandings about creativity located in definitions, key ideas in the field and models of creativity (epistemological focus).

### Discourses

The framing of debates, politics and issues in creativity through rhetorics and representations (criticality focus).

### Futures

New directions in which creativity might emerge (generative futures focus).

### Learning

The practices and pedagogies in educational settings that promote creativity or creative practices (practice focus).

These emergent domains, identified in Fig. 1, are important: firstly, for organizing and understanding the diverse academic and practice literatures about creativity from different thematic points of view; and secondly, for locating and discussing the possible impacts of research and thinking about creativity and technology on classrooms. The four domains surrounding the uneasy space of implementation at the center of the diagram are *not* fixed entities or in causal relationship with other parts, nor are they the only thematic ways to understand this complex and diverse literature. Rather, they should be seen as fluid and loosely interacting parts that reflect a current understanding of the changing, complex and emergent constructs of creativity and technology, with the accompanying implementation issues in educational practice.

Within each domain in Fig. 1, the sub-themes (presented as bulleted points) are possible, but not exclusive, focal points for future research. We offer them as suggestions to help readers conceptualize the types of themes that might fall within the domains. Thus, in the explication of each of the domains below, we do not discuss these sub-themes separately. They are synthesized in the following discussion that reflects their interwoven nature across the domains in research and practice.

### Domain 1: Meanings

The domain of Meanings focuses on understandings about creativity—in definitions, key ideas, and models of creativity. This domain informs what is known or believed about creativity and, thus, has an epistemological focus. This allows engaging with significant questions—implying tensions, provocations, or dilemmas which have no clear or immediate resolution, but demand attention. Definitions allow a shared understanding of the ideas at hand, while models and ideas guide research, practice, and policy around implementation.

Defining creativity is problematic: it contains both agreed-upon and uncertain ground. A common definition views creativity as the ability, capacity or skill to produce things that are novel and effective, known as the "standard definition" (Runco and Jaeger 2012). Novelty implies the creation of something that either did not exist before or is relatively original in context. But a novel idea with no potential use cannot be taken as creative (Cropley 2003). So creative things must also be "effective"—or useful, logical, understandable, or valuable to others.

Other definitions start from the standard definition and add an element of sensitivity to context (Mishra and Koehler 2008). This denotes creativity as a fluid, conceptual, interdisciplinary category that is socially and contextually situated. In the context of technologies and classrooms, there are uncertainties about whether and how shifts in knowing and doing in the digital age have shaped how creativity is done and conceived.

For instance, do digital technologies mitigate or facilitate creativity, and under what circumstances? Glück et al. (2002) found that creativity is grounded in intrinsic motivation and imagination, but also subject to external constraints. A person's freedom to choose their tools, modality, and context influences that person's capacity for creative learning (Barroso-Tanoira 2017). However, teachers and students operate with constraints, navigating tools, technologies, situational variables, and other constraining forces in schools.

In examining if or how technologies affect creativity, we must consider if digitality affords distinctive practices. Lee and Chen (2015) argue that it does, defining digital creativity as "the creativity manifested in all forms that are driven by digital technologies" (p. 12). This includes areas where creativity could not be achieved without the digital, e.g. generative art, design pattern/meta-design/design facilitating technologies, digital narratives, computer music, human–computer interaction, and more. Few of these areas have examined the intersection of digitality and creativity in schools, despite questions that arise in this space. For instance, how does framing impact this intersection of digitality and creativity—is it defined as 'digital creativity' or 'creativity through the digital'? There is nothing intrinsically creative about digital tools per se. Yet Shin (2010) emphasized the potential of digital creativity and suggested taking advantage of technologies for expression. Smith and Henriksen (2016) note the importance of digitality and arts learning toward expanding students' capacity for creativity and risk—but this, in turn, begs the question of what does 'risk' look like in classroom spaces and to what degree can it be supported?

Kaufman and Beghetto's (2009) Four-C model explicitly deals with creativity and risk within classrooms, supporting the kind of risk-taking that comes with trying/sharing new ideas in schools. Technologies may have unique capacities to mitigate risk in classroom creativity, by allowing for the testing of new ideas. The creativity levels in their model go beyond the already-known 'little c' and 'Big C' creativity (everyday creativity vs. big-picture creative breakthroughs). Kaufman and Beghetto's model added the levels of 'mini-c '(ordinary interpretive creativity seen in classrooms), and 'pro-c' (expert creativity). They note that creativity may exist at the micro- and the macro-levels in classrooms and suggest designing learning environments to foster creativity with technologies at different scales.

Yet, the core question for educators and students is what is a creative work worth? This raises the issue of gatekeeping via assessment. Glăveanu (2008) points out that conventional creativity assessments emphasize the evaluations of experts. This separates creativity from everyday contexts such as classrooms, which are social domains where students create with and through technologies to extend their thinking.

Issues of creativity and gatekeeping are embedded in the systems model of creativity (Csikszentmihalyi 1999), which considers *where* creativity is, not *what* it is—e.g. Csikszentmihalyi locates it in individuals (creative people), in domains (tools, technologies, knowledge, norms, and skills needed to facilitate creativity) and in fields (systems of gatekeepers, who judge creative accomplishments in disciplines). Yet this model is problematized by online and digital spaces where the lines of gatekeeping are blurred—as digital tools increasingly allow creators to bypass common/authorized gatekeepers (Henriksen et al. 2016a).

## The uneasy space of implementation

A challenge for educators in classrooms is how to utilize existing scholarly findings, definitions and discussions about creativity in ways that align with the realities of praxis. Creativity is positioned in twenty-first century rhetoric as being necessary for future work and learning. However, many meanings derived from scholarship (e.g. definitions, models, etc.) deal with creativity as an individual construct based on traits. Definitions or models offer abstractions—but classroom spaces deal with practicalities and the social-situatedness of learning. Educators in systems built on tight standards, norms, and guidelines may be unsure of what to do with creativity in light of the realities of assessment.

While rhetorics around digital technologies promote their promise in fostering creativity, there are unanswered questions around whether educators and educational systems recognize and provide opportunities for developing creativity in students. Important questions remain unanswered by research, such as: What creativities are privileged in educator judgments, and how can technologies support a broader range of creative practice and thinking? What are our pedagogical beliefs when we make judgments about creativity in education? Practical research is needed to more effectively translate academic ideas about creativity into praxis.

## Domain 2: Discourses

The domain of Discourses focuses on academic and professional literature, and also online popular spaces, that engage rhetorically with creativity, technologies and change—thus it focuses on criticality. These rhetorical understandings shape notions about the disposition of education given a greater focus on creativity in the context of digital change. Huckin et al. (2012) point to the power of language in forming understandings of key educational ideas, and the need for criticality in unravelling the links between politics, rhetoric and institutional practices. In this section, we adopt this approach to examine literature that positions creativity disparately in academic and public discourses.

In some literature, globalization, educational change and technologies have been linked with creativity and innovation, often through a linear model where creativity leads to innovation, which in turn leads to change (Dawson and Andriopoulos 2014). This discourse about change, creativity and innovation has been used by scholars such as Pratt (2017) to describe western cities and urban centers as new hubs for creativity with a global focus, leveraging creativity in shifting notions of cityscape. It has also been connected emphatically to digital technologies and the emergence of design thinking and practices across society and educational settings, with an eye to fostering so-called twenty-first century skills (Henriksen et al. 2016b; Norman and Verganti 2014). The rhetoric is, thus, quite utopian in identifying the profound personal and social benefits of the intersections of creativity with digital technologies, but without fully recognizing the embedded constraints. Not the least of these constraints is the need for equity in resource allocation to support creativity, nationally and internationally (Warschauer and Matuchniak 2010).

The connection between creativity, change, technology and innovation has often been associated with organizations, teams and corporations, creating a discourse of the individual embedded within organizational and networked notions of creativity (Glăveanu 2014; Thompson and Choi 2006). It has also been linked to neo-liberal views of society and education, where creativity is positioned politically as serving the corporate order and market politics and facilitating cultural production in a competitive system (Clegg 2008). As such, creativity is orientated pragmatically to entrepreneurship and couched in the language of positive change, corporatization, branding and industrial innovation (Jones 2010). Bassett-Jones (2005) points out that in the context of organizations, creativity is often proclaimed as being essential for corporate success, but the need for diversity (of approach and personnel) to foster creativity may run counter to promoting organizational cohesion and compliance.

Baer (2012) contends with this recent movement of transdisciplinary approaches to creativity and instead suggests that theorizing about creativity and considering its situated application should be discipline specific. His views run counter to the shift in public discourse and policy statements in recent years that see creativity as a generic concept, and

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thus applicable across the broad sweep of society and in education. This points to a possible tension between scholarly and the public discourses of creativity, and it raises the question of which discourses should educators believe about how creativity is best enacted in classrooms.

More recently, Means and Slater (2019) proposed that there has been a growing shift toward a more reactionary, post-neo-liberal environment, one characterized by overt corporate capture of economic, social and educational life that is profoundly anti-democratic and suggests a digital future that may be viewed as dystopian. If so, creativity, despite its roots in notions of novelty, free exploration, imagination and diversity, might conceivably be reframed to serve this late capitalistic endeavor with implicit and explicit control of public discourses by technology companies. Education might well sit within this reframing.

It is important, at the same time, to be aware also of the cultural frame of contemporary discourses about creativity. Creativity has also been viewed in much research as a western construct and presented as an idealization with utopian links to technology, innovation and change (Saad 2009). According to Sawyer (2011), a distinctly western cultural model or understandings about creativity might be built on possibly misleading ideas. This amounts to a dominant and pervasive narrative about what creativity can provide in the prevailing social and economic order driven by western conceptualizations (Baer 2011). Creativity could be viewed as a term that has been colonized with the distinct purpose of serving the progress-narrative of western society and used as a transformation catalyst through entrepreneurial culture, creative industries and innovative managerial outlook (Bilton 2007).

## The uneasy space of implementation

What does discussion of discourses, rhetoric and the politics of change have to do with classrooms? Glăveanu et al. (2016) suggested the need for new language in creativity research and practice. Perhaps this new language will come from the emerging intersections of different discourses (popular, policy, and academic)—about creativity, critical thinking, change, the future of education, entrepreneurship, and deep integration of technologies into learning. Given the access to online information and learning environments and the speed of communications—students, parents and educators are at the coalface of disparate and often competing discourses about creativity.

Globally, there is an apparent obligation for some degree of creativity in classrooms by teachers. But which discourses should inform curriculum and practice, and who controls these discourses—academics, policy-makers or industry? Clearly, the effects of disparate discourses on teaching require further investigation, so that the apparent disconnect between theory, research, fragmented discourses and classroom practice might be ameliorated.

## Domain 3: Futures

There is a small but emerging conceptual, curriculum and policy literature about Futures in education, linked to digitization, scalable online digital learning platforms (MOOCs being one example among many) and learning possibilities centered in creativity (Craft 2011, 2013; Ferguson 2019). There are, however, only a handful of empirical studies in teaching and learning contexts that engage with the link between education, futures and creativity in a direct or even implied ways (Ferguson 2011; Tsai and Lin 2016).

In the context of education, we understand the term 'futures' to mean trends, directions and shifts in teaching and learning that point to impending issues and needs. At the same time, we also recognize the disputed nature of this term, its transdisciplinary use, and the various ways that it has been understood and applied (Brown et al. 2016). Much of the thinking about futures and creativity has been embedded in the notion of twenty-first century skills, critical thinking with creativity and the digital milieu of these skills (Balcom Raleigh and Heinonen 2019; Facer 2012). This affects policy making and the imperative for educators to construct creative classrooms that develop 'skills for the future'.

The 2018 position paper of the OECD (Directorate for Education and Skills (OECD 2018), selected 2030 as the focal point for imagining an educational future. The paper identifies the necessity for a "shared vision" (p. 3) that centers on addressing students' needs in a "rapidly changing world" (p.3) built on developing technological as well as creative futures. Creativity, problem-solving and design thinking are pivotal to this so-called 'future-proofing' of students (Callahan 2019; Kagan et al. 2020). According to Montuori (2011) a creativity for the future, and the future of creativity, might sit in a post-normal conceptualization of creativity and creative practices. In this a more complex, ecological, imaginative and participatory notion of creativity dispels the neoliberal mythology that only certain individuals can be truly creative (Harris and de Bruin 2019).

The notion of 'futures' is also connected in the academic literature, and in industry discourses, to synchronous and asynchronous modes of digital delivery of education, together with new assemblages and entanglements of technologies that embody the notion of 'tech futures' (Perng 2019). These assemblages refer to online, mobile and emerging technologies linked to artificial intelligence (AI) and augmented reality (AR) (Leahy et al. 2019).

There is a vision for highly techno-centric, mobile and distributed futures in which the enacting of creativity in practice transcends geographic, biological and disciplinary boundaries to create high efficiencies in delivery. Holford (2019) suggests that efficient creativities and knowledge-making with machines and AI will be part of diverse digital futures where human creativities and subjectivities are interwoven with machine interactions and interventions. Such futures include the changing affordances of technologies, in juxtaposition with creativity and evolving multimodalities, including the potentialities of virtual AI- and AR-supported learning environments.

The literature is also clear on the concern about the ethical ground of these changes to education, creativity and emerging technologies. Indeed, UNESCO (2020) conceives of a global and unified vision for futures in which education, including creativity, is linked to broader notions of the sustainable development of humanity and the equity of development. Likewise, Mulgan (2019) envisions an ethical and person-centered future with technologies, such that creativity is not separated from but congruent with human embodiments and thinking.

## The uneasy space of implementation

Futures as an educational imperative may be in tension with the immediacy of classroom practices and teachers' knowledge around technologies and creativity. For many educators, notions of future, creativity and digital technologies could become highly disruptive for their pedagogies and practices. Clearly, there is a need for the translation of speculative thinking in this space to the practicalities of classrooms and educators who wish to engage with emergent ideas. AI seems futuristic but is already (albeit in limited forms) available and usable right now. AR is distributed in pockets and practice hubs that are well funded

by tech companies (as part of their economic reach) and philanthropic organizations but are not within the prevue of most schools. Furthermore, there is rarely enough time and space to embrace professional learning for educators to feel competent in this uncertain and emerging space. In the end, there is a need for educators to be a substantial part of futures thinking at the school level so that they can enact what the emerging research is envisioning.

## Domain 4: Learning

The domain of Learning focuses on international pedagogical and learning practices that promote creativity with and through technology—thus, it has a practice focus. This is a perpetually shifting space, since educational practices are contextual, technologies evolve, and pedagogy is deeply personal in the practices of teachers—pointing to a need for practitioner perspectives within research.

The relevant literature about creativity and pedagogical practices is fragmented and does not provide a cohesive view of practical findings related to technology. As Aguilar and Turmo (2019) note in their scoping literature review, there has been more emphasis on technology as a tool for creativity, rather than on teachers' practices. Overall though, generative pedagogical practices fit well with the use of technologies that support creativity (Sanabria and Arámburo-Lizárraga 2017). For instance, using learning-by-design practices with pre-service teachers (e.g. solving technological challenges using Lego Education toolsets) has shown promising results for developing creative pedagogical mindsets (established in Lee et al. 2014 qualitative case study wherein teachers' engaged in professional development for adaptive expertise around technology use). Generative design mindsets are also prevalent in the emphasis on reflective practices for fostering creativity (Razdorskaya 2015).

Creativity can be seen as an epistemological-pedagogical orientation, both as practice and discourse with students—as was determined by Hong et al. (2009) in a quantitative survey study of teachers' epistemological beliefs, motivation, and goal orientation around instructional practices that foster student creativity. However, Harris and de Bruin's (2017) qualitative study of teachers established that developing such a creative orientation can be challenging given systemic constraints (e.g. crowded curricula with onerous mandates). That said, other qualitative studies aiming to analyze practical literature or engage teacher perspectives have found that technology can help merge domains to allow more creative interdisciplinarity in teaching (e.g. Alter 2010; Harris and de Bruin 2018).

Despite an abundance of literature calling for more focus on developing creativity in students, there is a lack of evidence-based practices (see Egan et al. 2017 for a scoping review). This lack of evidence-based criteria may stem from the fact that many education settings make it difficult to move beyond existing curricular/assessment practices that marginalize creativity. In addition, creative practices may have an emergent or ephemeral character that resists standardization (MacLaren 2012).

To navigate this kind of emergent practice, DeHaan (2009) suggested making explicit the goals of creative learning, i.e. proposing a focus on cognitive flexibility for creativity and making this clear in instructional design. The deliberative and well-designed use of ICT within learning environments may promote this flexibility and engender creativity in students. The literature, however, is not clear about what such environments might look like, so teachers have little guidance for practice.

The field becomes even more fractured when we consider findings related to discipline-specific creative practices. Burnard's (2007) conceptual work offers framing principles for music pedagogy, noting that the 'deeper' object of musical learning arises inseparably from creativity and technology. Her call for more action research related to creativity and technology in music pedagogy also aligns with addressing the research-practice gap that we have emphasized.

While the arts are perceived as aligning more easily with creativity, scholars have also observed the important role played by technologies as tools of scientific progress; Root-Bernstein et al. (1995) established this in a mixed-method study of the practices of highly-accomplished creative scientists, and further work has noted the importance of creativity and imagination to high-level scientific practice (Root-Bernstein and Root-Bernstein 2013). This is despite the fact that teaching for creativity is often a low priority in science teaching (as noted in Al-Abdali and Al-Balushi's (2016) observational study of science teachers' practices). The arts might offer new approaches for teaching and learning in science and mathematics, because art-centered integrated learning can foster flexible thinking and inquiry (Marshall 2014).

### The uneasy space of implementation

The literature on creativity and technology is fragmented, making it difficult to enact consistent or defined classroom practices. Scholarly literature dealing with the messy socio-cultural spaces of classrooms is scarce, as compared to the broader sweep of psychology literature that addresses creative thinking in individuals. Educators have long known of the potential in the arts to foster and promote creativity and divergent thinking. But in considering what the arts can bring to other disciplines in schools, we need to understand what hampers these possibilities in policy and practice. A growth mindset built on reflexivity and design thinking is fundamental to creativity, but enacting such a mindset presumes a willingness for schooling to embrace it.

Finally, the issue of risk is unavoidable in dealing with creative practices and new technologies. School contexts that amplify the negative implications of creative risk may dampen learning possibilities. Acceptance of the in-between moments of struggle, doubt, and fear may allow teachers and learners to welcome the moments of risk and exploration without a prescribed path forward. We assert that moments of exploration, experimentation and discovery necessitate support from administration and grounding in empirical research.

### Limitations and future directions

The paper has several limitations, revealed through the synthesis of domains. The four domains that we describe (Learning, Meanings, Discourses, and Futures) emerged from our critical review of the literature. We formed these domains into a descriptive model, based on a snapshot of the current status (strengths and weaknesses) of scholarship in these areas. The findings are therefore limited by the search method and the subjectivity inherent and explicitly recognized in this form of critical interpretivist review of the literature (Barnett-Page and Thomas 2009). Dixon-Woods et al. (2006) argue that this method, imbued with inductive and non-linear search methods, lends itself to theory generation in unmapped or emerging fields.

However, we must point to another gap and absence with implications for future directions. This involves uncertainty in the relationship between these four domains. This lack of clarity about a causal or explanatory relationship between these constructs implies that there is still much work needed. A key question here is, why these four domains and not others? This could be a function of our particular reading and interpretation of the literature in the field and may reflect the limitations of our approach. This paper, in seeking to describe the contours of the field and proffering implications, does not offer explanatory frameworks or theories.

But we also assert that there may be something deeper, reflecting a fundamental issue of the core constructs themselves. These constructs (creativity, technologies, teaching and learning) at the center of this paper are complex, often highly contextual, and lack understood causal alignments with each other. This may well be a property of the fields, reflecting a limited understanding of the intertwined phenomena. This leaves an open space to be filled, with a range of needed new alignments—which could be better understood through more research conducted in conjunction with practitioners—returning us again to Schön's (1995) assertion of the need for a new epistemology of practice, in the purview of research and academia.

## Conclusion

Internationally, creativity and technology have been positioned as essential components of educational outcomes and futures. Their importance in twenty-first century learning discourses is unequivocal, especially considering the corporatization of education, globalization and the perceived need to innovate to survive. Despite this importance—these constructs have not been linked in a cohesive body of research informing classroom practices.

One of the challenges of enacting creativity and technology in learning spaces involves these constructs' variations in practical perspectives and disciplinary lenses. These variations expand the complexity and perceived subjectivity in research and practice, wherein different stakeholders (teachers, administrators, researchers, policy-makers, parents, students, etc.) may have different or competing needs, priorities, and beliefs or values, as to where and how creativity and/or technology should emerge in teaching and learning. This enhances the challenge of scholarly production in this space.

Our discussion in the Meanings domain reveals that despite some agreed-upon ground in the basic definition of creativity, there are many definitional threads or models that shape understandings of the construct. Moreover, there are no clear-cut guidelines about how to recognize creativity or assess its worth, or even to determine who are the appropriate gatekeepers for its evaluation, or what evaluative measures to use.

In the Discourses domain we contend with the mediation of creativity through technology and the rhetoric of technology in education. Several examples of big technology corporations sponsoring educational projects demonstrate how creativity and innovation in education have become enmeshed with the techno-imperialist discourses of these corporations. The efficacy of technologies as tools or instruments to foster creativity may be uncertain, yet also filled with promise as well.

In the Futures domain, digital technologies are viewed as core to creativity in contemporary teaching practice and education futures. Technologies may offer ways to connect the disparate approaches to creativity that exist through hybrid creative practices and innovative assemblages. More work, however, is needed on converging or hybrid practices and

what creative futures entail in the affordances of new technologies (such as the role of augmented reality, artificial intelligence and other emerging technologies), and, importantly, what these futures might look like in the classroom.

Finally, as noted in the Learning domain, there are professional and academic conceptualizations about creativity in practice, such as the potential of design-based thinking, authentic learning, or reflective practice. However, there is an apparent lack of common ground about how these conceptualizations translate into policy, curriculum, the design of learning spaces. While creativity is widely discussed, it is too easily marginalized within the dominant discourses of policy, many of which are increasingly about standardization and thus, may be antithetical to creativity (Henriksen et al. 2019).

It should be noted here too, that empirical studies on futures thinking are somewhat limited overall, but especially in the space of education. Leahy et al. (2019) give several reasons for this and emphasize the need for more work. Futures thinking is the key to not just participatory, but also forward-looking or preparedness research—where educational systems could be better prepared for new developments and trends, or even unexpected or concerning occurrences (e.g. better equipped for major or unforeseen challenges, such as the current 2020 global pandemic). Leahy et al. point out that futures thinking may feel uncertain or non-intuitive, but it is critical that researchers engage such methodologies to inform and prepare the field of practice for what lies ahead.

The literature overall offers little solid ground for practitioners, and in some ways tends to avoid the reality of engaging with practice. It is characterized by disparate threads emerging across creativity, technology and education; and despite a range of interesting or promising individual studies, there is yet little cohesion around what practitioners might take away for their own classrooms.

We suggest this is partly due to a lack of research-in-practice, as we found little research that examines the creativity-technology relationship from within the classroom, or from the perspective of teachers and students in situ. Most of the research in the nexus of creativity, technology and education is conducted from an etic perspective—outside the experiences of practitioners. The most pressing need may be an emic perspective that can help develop grounded knowledge that is both informed by and informs practice. This is a call for action research grounded in practice and reflecting the views and experiences of educators. Only through this can effective implementation of creativity with and through technology emerge in the uneasy space of classrooms.

We recognize that we may leave the reader with a sense of a lack of resolution for the "uneasy space of implementation". It would be ideal to point to transformative classroom practices that embrace creativity, technology and education and empower teachers. We argue, however that having an unresolved space actually highlights the need for further classroom-based empirical research, including participatory and/or action research involving practitioners, and therefore greater cohesion between research, policy, and practice. This review also suggests that the research story that we have sketched, and its implications for practice, is only just beginning.

## Compliance with ethical standards

**Informed consent** Given the above nature of this publication as a literature review, there was no requirement for informed consent.

# References

Aguilar, D., & Turmo, M. (2019). Promoting social creativity in science education with digital technology to overcome inequalities: a scoping review. *Frontiers in Psychology, 10,* 1–16.

Al-Abdali, N. S., & Al-Balushi, S. M. (2016). Teaching for creativity by science teachers in grades 5–10. *International Journal of Science and Mathematics Education, 14*(2), 251–268.

Alter, F. (2010). Using the visual arts to harness creativity. *The University of Melbourne Refereed e-journal*, 1(5).

Baer, J. (2011). Why grand theories of creativity distort, distract and disappoint. *International Journal of Creativity & Problem Solving, 21*(1), 73–100.

Baer, J. (2012). Domain Specificity and the Limits of Creativity Theory. *Journal of Creative Behavior, 46,* 16–29.

Balcom Raleigh, N. A., & Heinonen, S. (2019). Entangling and elevating creativity and criticality in participatory futuring engagements. *World Futures Review, 11*(2), 141–162.

Barnett-Page, E., & Thomas, J. (2009). Methods for the synthesis of qualitative research: a critical review. *BMC Medical Research Methodology, 9*(59), 1–11.

Barroso-Tanoira, F. G. (2017). Motivation for increasing creativity, innovation and entrepreneurship. An experience from the classroom to business firms. *Journal of Innovation Management, 5*(3), 55–74.

Bassett-Jones, N. (2005). The paradox of diversity management, Creativity and innovation. *Creativity and Innovation Management, 14*(2), 169–175.

Buchanan, R. (1992). Wicked problems in design thinking. *Design issues, 8*(2), 5–21.

Burnard, P. (2007). Reframing creativity and technology: Promoting pedagogic change in music education. *Journal of Music, Technology & Education, 1*(1), 37–55.

Bilton, C. (2007). *Management and creativity: From creative industries to creative management*. London, UK: Blackwell Publishing.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77–101.

Brown, N., Rappert, B., Webster, A., & (Edits.), . (2016). *Contested futures: A sociology of prospective techno-science*. USA: Routledge.

Callahan, K. (2019). *Design thinking in curricula*. Wiley, Hoboken, NJ: The international encyclopedia of art and design education.

Charmaz, K. (2003). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies for qualitative inquiry* (2nd ed., pp. 509–535). Thousand Oaks: SAGE Publications.

Clegg, P. (2008). Creativity and critical thinking in the globalised university. *Innovations in Education and Teaching International, 45*(3), 219–226.

Collins, H. (2019). *Creative Research. The theory and practice of research for the creative industries* (2nd ed.). London: Bloomsbury Visual Arts.

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: The digital revolution and schooling in America* (2nd ed.). New York, USA: Teachers College Press.

Cropley, A. J. (2003). *Creativity in education & learning*. Falmer, USA: Routledge.

Craft, A. (2011). *Creativity and education futures: Learning in a digital age*. London, UK: Trentham Books.

Craft, A. (2013). Childhood, possibility thinking and wise, humanising educational futures. *International Journal of Educational Research, 61,* 126–134.

Csikszentmihalyi, M. (1999). A systems perspective on creativity. In R. Sternberg (Ed.), *Handbook of Creativity* (pp. 313–335). Cambridge, UK: Cambridge University Press.

DeHaan, R. L. (2009). Teaching creativity and inventive problem solving in science. *CBE—Life Sciences Education, 8*(3), 172–181.

Directorate for Education and Skills (OECD). (2018). The future of education and skills Education, 2030. OECD. https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf

Dixon-Woods, M., Bonas, S., Booth, A., Jones, D., Miller, T., Shaw, R., et al. (2006). How can systematic reviews incorporate qualitative research? A critical perspective. *Qualitative Research, 6,* 27–44.

Duffy, G., Gallagher, T., & T. . (2017). Shared education in contested spaces: How collaborative networks improve communities and schools. *Journal of Educational Change, 18*(1), 107–134.

Dawson, P., & Andriopoulos, C. (2014). *Managing change, creativity and innovation* (2nd ed.). London: Sage.

Egan, A., Maguire, R., Christophers, L., & Rooney, B. (2017). Developing creativity in higher education for 21st century learners: A protocol for a scoping review. *International Journal of Educational Research, 82,* 21–27.

Eliot, J. A., & Hirumi, A. (2019). Emotion theory in education research practice: an interdisciplinary critical literature review. *Educational Technology Research and Development, 67*(5), 1065–1084.

Facer, K. (2012). Taking the 21st century seriously: young people, education and socio-technical futures. *Oxford Review of Education, 38*(1), 97–113.

Ferguson, R. (2011). Meaningful learning and creativity in virtual worlds. *Thinking Skills and Creativity, 6*(3), 169–178.

Ferguson, R. (2019). Teaching and learning at scale: futures. In R. Ferguson, A. Jones, & E. Scanlon (Eds.), *Educational Visions: Lessons from 40 years of innovation* (pp. 33–50). London: Ubiquity Press.

Geisinge, K. (2016). 21st Century Skills: What are they and how do we assess them? *Applied Measurement in Education, 29*(4), 245–249.

Glăveanu, V. (2008). Research methods in social psychology A comparative analysis. *Europe's Journal of Psychology.* https://doi.org/10.5964/ejop.v4i1.421.

Glăveanu, V. (2014). *Distributed creativity: Thinking outside the box of the creative individual*. Cham: Springer.

Glăveanu, V., Tanggaard, L., & Wegener, C. (2016). Why do we need a new vocabulary for creativity? In V. Glăveanu, L. Tanggaard, & C. Wegener (Eds.), *Creativity A New Vocabulary. Palgrave Studies in Creativity and Culture* (pp. 1–9). London: Palgrave Macmillan.

Glück, J., Ernst, R., & Unger, F. (2002). How creatives define creativity: Definitions reflect different types of creativity. *Communication Research Journal, 14*(1), 55–67.

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal, 26*(2), 91–108.

Grant, M. M. (2019). Difficulties in defining mobile learning: analysis, design characteristics, and implications. *Educational Technology Research and Development, 67*(2), 361–388.

Hall, C., & Thomson, P. (2008). Creative tensions? Creativity and basic skills in recent educational policy. *English in Education, 39*(3), 5–18.

Harris, A., & de Bruin, L. (2017). STEAM education: Fostering creativity in and beyond secondary schools. *Australian art education, 38*(1), 54.

Harris, A., & de Bruin, L. R. (2018). Secondary school creativity, teacher practice and STEAM education: An international study. *Journal of Educational Change, 19*(2), 153–179.

Harris, A., & de Bruin, L. (2019). Creative ecologies and education futures. In C. Mullen (Ed.), *Creativity Under Duress in Education? Creativity Theory and Action in Education* (Vol. 3). New York: Springer.

Henriksen, D., Hoelting, M., & Deep-Play Research Group. (2016). A systems view of creativity in a YouTube world. *TechTrends, 60*(2), 102–106.

Henriksen, D., Mishra, P., & Fisser, P. (2016). Infusing creativity and technology in 21st century education: A systemic view for change. *Educational Technology & Society, 19*(3), 27–37.

Henriksen, D., Creely, E., & Henderson, M. (2019). Failing in creativity: The problem of policy and practice in australia and the United States. *Kappa Delta Pi Record, 55*(1), 4–10.

Henriksen, D., Henderson, M., Creely, E., Yadav, A., Good, J., Foster, A., et al. (2018). What is the relationship between technology and creativity? In *Symposium presented at The Society for Information Technology & Teacher Education International Conference 2018*, Washington, DC.

Hong, E., Hartzell, S. A., & Greene, M. T. (2009). Fostering creativity in the classroom: Effects of teachers' epistemological beliefs, motivation, and goal orientation. *The Journal of Creative Behavior, 43*(3), 192–208.

Holford, W. D. (2019). The future of human creative knowledge work within the digital economy. *Futures, 105,* 143–154.

Huckin, T., Andrus, J., & Clary-Lemon, J. (2012). Critical discourse analysis and rhetoric and composition. *College Composition and Communication, 64*(1), 107–129.

Jones, R. (2010). Creativity and discourse. *World Englishes, 29*(4), 467–480.

Kagan, S., Antoniya, H., Helldorff, S., & Weisenfeld, U. (2020). Jamming sustainable futures: Assessing the potential of design thinking with the case study of a sustainability jam. *Journal of Cleaner Production, 251,* 119595.

Kaufman, J., & Beghetto, R. (2009). Beyond Big and Little: The Four C Model of Creativity. *Review of General Psychology, 13*(1), 1–12.

Leahy, S., Holland, C., & Ward, F. (2019). The digital frontier: Envisioning future technologies impact on the classroom. *Futures, 113,* 102422.

Lee, K. T., Chalmers, C., Chandra, V., Yeh, A., & Nason, R. (2014). Retooling Asian-Pacific teachers to promote creativity, innovation and problem solving in science classrooms. *Journal of Education for Teaching, 40*(1), 47–64.

Lee, M. R., & Chen, T. T. (2015). Digital creativity: Research themes and framework. *Computers in human behavior, 42,* 12–19.

Levine, A. (2007). Educating researchers. The Education Schools Project.

Lin, Y. (2014). A third space for dialogues on creative pedagogy: Where hybridity becomes possible. *Thinking Skills and Creativity, 13,* 43–56.

MacLaren, I. (2012). The contradictions of policy and practice: Creativity in higher education. *London Review of Education, 10*(2), 159–172.

Marshall, J. (2014). Transforming education through art-centred integrated learning. *Visual Inquiry*, *3*(3), 361–376.

Means, A., & Slater, G. (2019). The dark mirror of capital: on post-neoliberal formations and the future of education. *Discourse: Studies in the Cultural Politics of Education*. https://doi.org/10.1080/01596 306.2019.1569876.

Mehta, R., Henriksen, D., & Rosenberg, J. M. (2019). It's not about the tools. *Educational Leadership, 76*(5), 64–69.

Mishra, P., & Koehler, M. J. (2008). Introducing technological pedagogical content knowledge. In annual meeting of the American Educational Research Association (pp. 1–16).

Mishra, P., & Mehta, R. (2017). What we educators get wrong about 21st-century learning: Results of a survey. *Journal of Digital Learning in Teacher Education, 33*(1), 6–19.

Montuori, A. (2011). Beyond postnormal times: The future of creativity and the creativity of the future. *Futures, 43*(2), 221–227.

Moustakas, C. (1994). *Phenomenological research methods*. California: Sage publications.

Mulgan, T. (2019). Corporate agency and possible futures. *Journal of Business Ethics, 154,* 901–916.

Norman, D., & Verganti, R. (2014). Incremental and radical innovation: Design research vs. technology and meaning change. *Design Issues, 30*(1), 78–96.

Novak, E. (2015). A critical review of digital storyline-enhanced learning. *Educational Technology Research and Development, 63*(3), 431–453.

Paré, G., & Kitsiou, S. (2016). Methods for literature reviews. In F. Lau & C. Kuziemsky (Eds.), *Handbook of eHealth evaluation: an evidence-based approach* (pp. 157–180). Canada: University of Victoria.

Perng, S. (2019). Anticipating digital futures: ruins, entanglements and the possibilities of shared technology making. *Mobilities, 14*(4), 418–434.

Pratt, A. (2017). New horizons for culture, creativity and cities. *City, Culture and Society, 8,* 1–2.

Razdorskaya, O. (2015). Reflection and creativity: the need for symbiosis. *Procedia-Social and Behavioral Sciences, 209,* 433–438.

Root-Bernstein, R. S., Bernstein, M., & Garnier, H. (1995). Correlations between avocations, scientific style, work habits, and professional impact of scientists. *Creativity Research Journal, 8*(2), 115–137.

Root-Bernstein, R., & Root-Bernstein, M. (2013). The art and craft of science. *Educational Leadership, 70*(5), 16–21.

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity research journal, 24*(1), 92–96.

Saad, G. (2009, Jul 13). Cross-cultural differences in creativity: Do cultural traits affect individuals' creativity? *Psychology Today*. https://www.psychologytoday.com/us/blog/homo-consumericus/200907/cross -cultural-differences-in-creativity

Sanabria, J. C., & Arámburo-Lizárraga, J. (2017). Enhancing 21st century skills with AR: Using the gradual immersion method to develop collaborative creativity. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(2), 487–501.

Sawyer, K. (2011). The western cultural model of creativity: Its influence on intellectual property law. *Notre Dame Law Review*, 86, 2027–2056. http://scholarship.law.nd.edu/ndlr/vol86/iss5/10

Schön, D. A. (1995). Knowing-in-action: The new scholarship requires a new epistemology. *Change: The Magazine of Higher Learning, 27*(6), 27–34.

Shin, R. (2010). Taking digital creativity to the art classroom: Mystery box swap. *Art Education, 63*(2), 38–42.

Smith, S., & Henriksen, D. (2016). Fail again, fail better: Embracing failure as a paradigm for creative learning in the arts. *Art Education, 69*(2), 6–11.

Sullivan, F. R. (2017). *Creativity, technology, and learning: Theory for classroom practice*. Abingdon, UK: Taylor & Francis.

Tsai, M.-Y., & Lin, H.-T. (2016). The effect of future thinking curriculum on future thinking and creativity of junior high school students. *Journal of Modern Education Review, 6*(3), 176–182.

Thompson, L., & Choi, H. (2006). *Creativity and innovation in organizational teams*. London, UK: Psychology Press.

UNESCO. (2020). Futures of Education. Learning to become. A global initiative to reimagine how knowledge and learning can shape the future of humanity and the planet. https://en.unesco.org/futuresofeducation/

Van Laar, E., van Deursen, A. J., van Dijk, J. A., & de Haan, J. (2019). Determinants of 21st-century digital skills: A large-scale survey among working professionals. *Computers in human behavior, 100,* 93–104.

Walsh, D., & Downe, S. (2005). Meta-synthesis method for qualitative research: a literature review. *Journal of advanced nursing, 50*(2), 204–211.

Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education, 34*(1), 179–225.

Zhao, Y. (2012). *World class learners: Educating creative and entrepreneurial students*. Thousand Oaks, USA: Corwin Press.

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