MEASURING STUDENT SUCCESS SKILLS: A REVIEW OF THE LITERATURE ON CREATIVITY

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21st CENTURY SUCCESS SKILLS

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MEASURING STUDENT SUCCESS SKILLS: A REVIEW OF THE LITERATURE ON CREATIVITY

INTRODUCTION

Everybody has creative potential, and from the moment you can express this creative potential, you can start changing the world. – Paulo Coelho

Creativity is essential in today's world. Creative insights and advances influence improved learning conditions and innovations for addressing global challenges. Moreover, technological advances make information universally available, which has rapidly accelerated progress across economic sectors. These advances have major implications for educators and, further, the knowledge and skills students need to succeed in the information age. According to the World Economic Forum (2020), employers view creativity as one of the five most prominent and in-demand skills of the future. Importantly, creativity involves complex problem-solving, critical thinking, and innovation—skills that account for three of the four remaining top-five skills of the future (World Economic Forum, 2020).

The primary goals of this literature review are to (a) provide a working definition of creativity, (b) describe how creativity develops, (c) examine different conceptions of how creativity is taught, (d) discuss specific instructional practices that support the development of creativity and creative-thinking strategies, and (e) analyze how creativity has been assessed. Additionally, I consider the corresponding implications for the design and use of creativity assessments in K-12 schools. I conclude by offering best practices for documenting and evaluating creativity and creative thinking skills over time.

DEFINITIONS

What Does it Mean to Be Creative?

Historical definitions of creativity varied widely across fields of study (Plucker et al., 2004; Ramalingam et al., 2020) and often portrayed creativity as being inaccessible to the masses. Early conceptions were primarily associated with the arts and prompted misperceptions regarding creativity and creative potential. For example, early researchers posited that creativity was a genetic gift, creative skills could not be learned, creative people tended to be nonconformist and reclusive, and the creativity construct was unmeasurable. Moreover, early research suggested that creative abilities were fixed and reserved only for the fortunate few (Baer, 2012; Feist, 1998). Over the past several decades, the science on creativity has converged (Patston et al., 2021; Puryear & Lamb, 2020) and myths have been debunked. Plucker et al., (2004) synthesized common elements across definitions of creativity and, in turn, offered a clear and useful definition to guide future research:

> Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context (p. 90, emphasis retained from original definition).

The creativity construct includes both general and context-specific knowledge, skills, and dispositions. Moreover, aspects of creativity vary across individuals and shift in application as a learner develops domain-

specific expertise. In the context of assessment, judgments of creativity can occur through multiple lenses (Rhodes, 1961):

- **person:** personality features and dispositions of an individual.
- **process:** the observable learning and thinking involved in a creative act.
- **product:** a tangible result of the creative process.
- **press:** the environment and other social factors that influence the creative process.

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Each creative component—person, process, product, and press—provides evidence for evaluating creativity (Patston et al., 2021). For example, each person has individual attributes that influence the development of creative skills and capacities: curiosity, resilience, openness to new experiences, willingness to take sensible risks, and tolerance for ambiguity, to mention a few. The creative process involves concrete skills and strategies that are set into motion by an initial problem or question. Possible solutions are generated, and later selected, through both divergent (idea generation) and convergent (critical selection) thinking strategies. Throughout the process, ideas are analyzed from multiple perspectives, new or unexpected connections are established, and alternative solutions are considered and selected for implementation. The product provides evidence for evaluating a person's creativity in a social context. For example, criteria for determining whether a painting is creative will differ depending on whether those artists are fifth graders or professionals. Thus, understanding how social and contextual factors influence judgments of creativity is essential in developing creative potential. Finally, press, which includes both physical-environment and psychological factors, can be manipulated to either enhance or inhibit creativity.

The Creative Person

The creative person demonstrates motivational, affective, and cognitive habits of mind that influence the creative process. Relevant factors include a person's openness to taking intellectual risks, tolerance for ambiguity, resilience, independent thinking, and a propensity for nonconformity (Amabile, 1998; Kaufman et al., 2016). Moreover, creative abilities are fluid, not fixed: they grow through training and experience as an individual develops creative habits of mind and learns how to access and use their creative abilities (Plucker et al., 2004). Claxton et al. (2006) identified six habits of mind most supportive of creativity:

- **curiosity:** an appetite for questioning things, wondering about things, and engaging in "problem-finding."
- **resilience:** the ability to tolerate confusion and frustration, to relish a problem, and to persist through challenges.
- **experimenting:** approaching materials, ideas, actions, and possibilities with a sense of openness, playfulness, and enjoyment.
- **attentiveness:** concentrating intensely and effortlessly, becoming whole-heartedly absorbed in an experience, looking carefully at what exists and seeing clues that spark new insights.

- **thoughtfulness:** making productive use of cognitive processes, which include pondering over questions and possibilities, thinking carefully and methodically, regulating emotions, and testing one's intuition and hunches.
- **environment-setting:** regulating the outside world to support the creative process by, for example, surrounding oneself with people who support creative thinking, balancing time for hard work and play, and engaging in creative thinking during times that are most conducive for such activities.

Lucas (2016) later proposed a similar model of creative habits of mind, which included five creative dispositions: inquisitive, imaginative, persistent, collaborative, and discipline. Similarly, the Organization for Economic Co-operation and Development (OECD; Organization for Economic Co-operation and Development, 2019), through its synthesis of creativity research, identified several individual and social "enablers" of creative thinking (shown in Table 1).

Table 1.
Individual Enablers of Creative Thinking (OECD, 2019)

Individual Enablers
Cognitive Skills
Domain Readiness
Openness to Experience and Intellect
Goal Orientation
Creative Self-Beliefs
Task Motivation

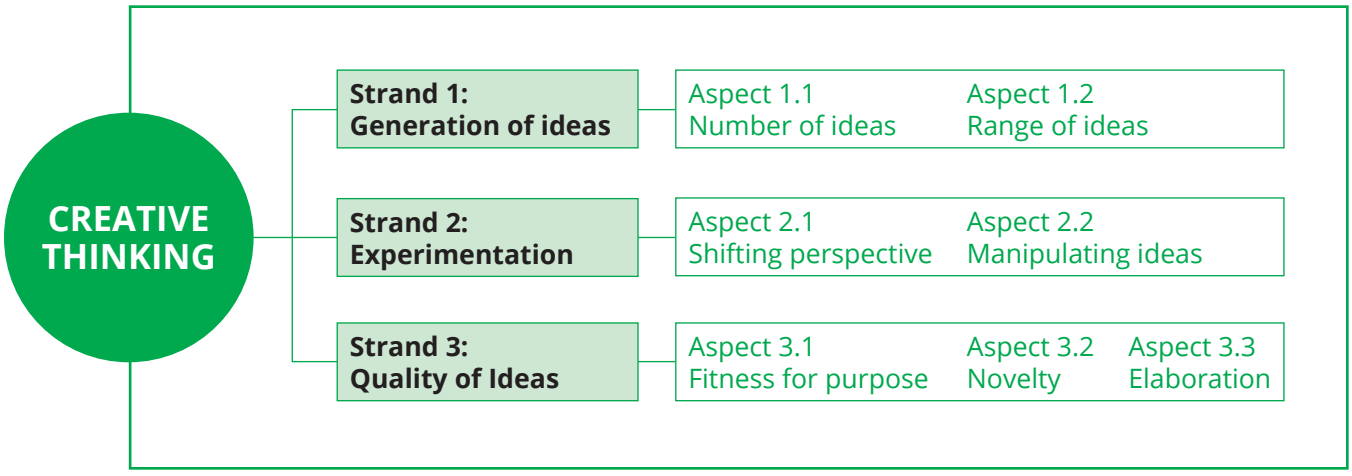
The Creative Process

The creative process refers to how people approach a problem and arrive at novel and useful solutions (Amabile, 1998; Jung, 2001). The Australian Council for Education Research (ACER) recently proposed a framework for assessing creative thinking, which primarily is concerned with process rather than the creativity construct more generally. ACER defined creative thinking as

> the capacity to generate many different kinds of ideas, manipulate ideas in unusual ways, and make unconventional connections in order to outline novel possibilities that have the potential to elegantly meet a given purpose. (Ramalingam et al., 2020, p. 5)

ACER's definition encompasses three overarching strands and seven aspects, as shown in Figure 1. Below, I describe each strand and the associated aspects.

Figure 1:
ACER's Creative Thinking Skill Development Framework



Strand 1: Generation of ideas. At its core, creative thinking is a generative process: It involves the production of many different ideas through divergent thinking. Popularized by J.P. Guilford (1950, 1968), the concept of divergent thinking later adapted to become the framework for the well-known Torrance Tests of Creative Thinking. This framework included four subskills:

- **fluency:** the ability to generate many ideas.
- **flexibility:** the ability to produce a variety of ideas.
- **originality:** the ability to produce novel and unusual ideas.
- **elaboration:** the ability to fully develop ideas.

Although divergent thinking is an essential element of creativity, it is only part of the creative process and one of several indicators of creative potential (Lai, 2018). The number and range of novel or unusual ideas—captured in fluency, flexibility, and originality—are key aspects of idea generation.

Strand 2: Experimentation. Experimentation involves the ability to consider ideas from multiple perspectives and generate new ideas within the constraints of a problem. The ability to shift across multiple perspectives allows the creative thinker to redefine a problem's context (i.e., the problem's goals, constraints, and environmental conditions) and therefore arrive at new ways to approach the problem. Experimentation also involves manipulating and synthesizing ideas and, in turn, adapting them to develop new approaches to a problem. For example, a teacher's ability to develop novel and useful solutions to classroom-based problems relies on her ability to consider the problem from different students' perspectives as they experience them at different points during the day, from different physical locations, and/or when working alone or with others. As she considers the problem from a variety of perspectives, she may come to understand the problem differently from her colleagues and, ultimately, address the problem in an entirely new way.

Strand 3: Quality of ideas. The quality of an idea entails three aspects: (a) fitness (i.e., usefulness) for a purpose, (b) novelty, and (c) elaboration, or the ability to sufficiently communicate the idea and explain how it solves a problem.

The ACER authors introduce some caveats for how this strand relates to the young or inexperienced learner. First, they acknowledge that such learners may generate ideas that are novel to them, although not necessarily novel in an absolute sense. That is,

> generating novel or original ideas is relative to, and dependent on, the social context. For example, a learner may generate ideas that are highly unusual in comparison with their classmates', but they may be similar to ideas generated in a different class. Ideally, learners can work in a context in which the evaluation of the novelty or originality of an idea is generous enough that it provides opportunities for success while also challenging learners to think differently. (Ramalingam et al., 2020, p. 8)

A second caveat is that elaboration may be limited by the learner's prior knowledge. For example, a learner may be able to develop novel ideas but unable to explain how the idea improves upon more common ideas.

The Creative Product

The creative product provides evidence of two essential elements of creativity: novelty and usefulness (Kaufman et al., 2016). That is, while the creative process produces something that is new and different, such originality is not sufficient. Rather, for something to be creative it also must be useful, or appropriate, for achieving an aim or solving a problem. Simonton (2012) framed creativity as a function of originality multiplied by appropriateness: C = (O x A). Creative products may take a variety of forms, such as physical

structures (models to illustrate science/engineering concepts), historical reproductions, artistic creations, written essays, oral presentations and discussions, mathematical models, and scientific experiments.

By working backward from a creative product, one can make inferences regarding latent critical-thinking processes. For example, the product's novelty—its originality and deviation from convention—suggests divergent and convergent reasoning, just as written documents and oral presentations are evidence of an individual's ability to elaborate on the ways in which product features address a problem.

The Creative Press

The creative press includes environmental conditions that influence an individual's creative development and potential. Davies et al. (2013) identified several important factors that support creative skills development in school-aged children:

- flexible use of space and time
- availability of appropriate materials
- working outside the classroom/school; providing learners autonomy
- respectful relationships between teachers and learners
- opportunities for peer collaboration; partnerships with outside agencies
- awareness of learners' needs
- non-prescriptive planning

Amabile (2020), in contrast, recently reported several factors that can undermine creativity: expecting that one's product will be evaluated, being watched while working, engaging in a task for extrinsic pay or reward, being constrained in how to do a task, and competing with peers. The irony in Amabile's (2020) findings is clear: by making formative judgments of a novice learner's creative potential – presumably with the intent to enhance this potential – the teacher actually may be destroying it.

Creativity in a Social Context

Creativity is a socially defined construct; what constitutes a creative idea or product is bound within a particular social context. The systems model of creativity proposed by Csikszentmihalyi (1999) illustrates this idea. Csikszentmihalyi posits that what is deemed creative is not the product of a single individual. Rather, the product emerges from a social system that makes judgments about an individual's product. In other words, *the audience is as just as important as the individual creator* when determining the extent to which something is creative.

Creativity is a socially defined construct; what constitutes a creative idea or product is bound within a particular social context.

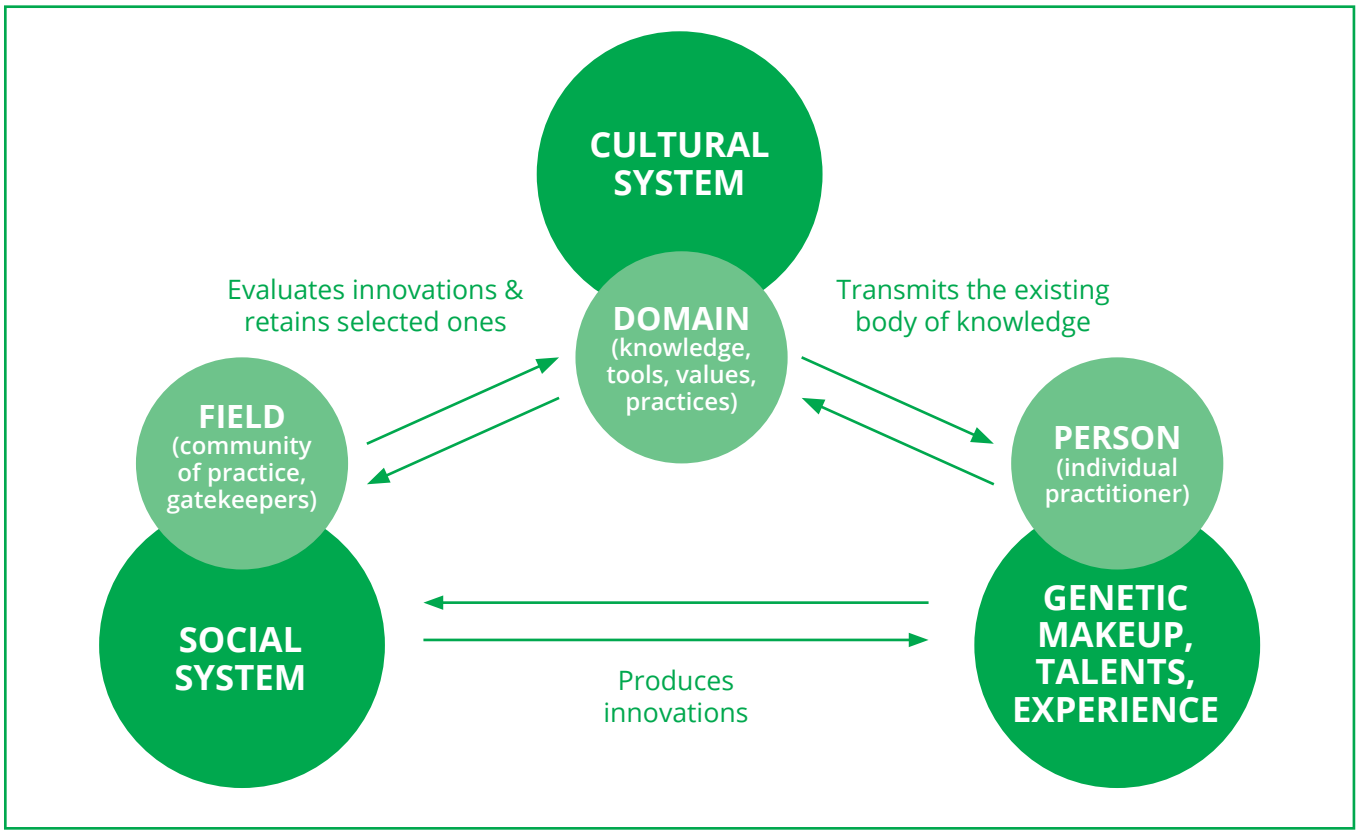
As Figure 2 shows, creativity evolves as a person produces a product for people living within a larger cultural system (i.e., those who share ways of thinking and acting, who learn from each other, and who imitate actions of others). This cultural system (located at the top of the figure) can be described as the commonly accepted knowledge, tools, values, and practices of a group. The cultural system is made up of a variety of domains. Music, mathematics, language, religion, technology represent examples of domains. Domains vary in terms of their organization, accessibility, and susceptibility to change. Domains that are highly organized have well-defined and commonly accepted ways of doing things. Domains that are highly accessible include ways of making knowledge accessible to the masses. Conversely, inaccessible domains have knowledge and

rules that are difficult to access unless a person is from a certain social class or has pre-specified certifications. Domains susceptible to change are those that are free from political and social control (e.g., in U.S society., technology is much more susceptible to change than religion).

To be called creative, a product must also be socially valued and accepted by those within a given field. A society will distinguish ideas that are simply novel from those that are both novel and useful, or appropriate. Additionally, gatekeepers – a group of experts in a domain – are selected within a field of study to evaluate a creative product based on its usefulness in improving or enhancing commonly accepted theories and ideas. Those gatekeepers, or experts, must first deem the product to be creative before it is introduced into the larger society (i.e., the social system) to be deemed creative. For example, before the iPhone was introduced to the public, it had to be approved by a small field of technology and communications specialists. Had those specialists not approved the design, the iPhone may have never seen the light of day.

Finally, although a product is introduced by an individual, the concept of creativity is not solely an individual trait that can be understood by studying the individual. This is because the individual must first have access to a domain, which is situated within the larger cultural and social system. In this way, a person's creative potential interacts with the state of the domain and the field as it evolves within a society. An individual engages in the creative process as a member of these larger systems, which carry a set of norms and values that influence whether a novel idea is deemed useful. Thus, a product may be novel but quickly forgotten unless it is sanctioned by the gatekeepers entitled to make decisions about what should or should not be included in a domain.

Figure 2:
Systems Model of Creativity (Csikszentmihalyi, 2006)



What is the Relationship Between Creativity and Other Success-Skill Concepts?

Creativity is often categorized with other success skills. For example, the Assessment and Teaching of 21st Century Skills framework (Binkley et al., 2012) combines creativity and innovation with critical thinking, problem-solving, learning to learn, and metacognition to form a "ways of thinking" category. Similarly, the National Research Council (2012) report broadly organizes the 21st Century Skills into one of three competency domains: cognitive, interpersonal, and intrapersonal. "Creativity" is one of three sub-domains listed under the cognitive domain, along with "cognitive processes and strategies" and "knowledge." Moreover, while creativity is often grouped with other cognitive skills, intrapersonal competencies (e.g., curiosity, persistence) and interpersonal skills (e.g., collaboration) may influence a person's creativity. Below, I discuss the relationship between creativity and several salient 21st Century Skills: critical thinking, problem-solving, complex communication, innovation, and collaboration.

Creativity and Critical Thinking

Many researchers have connected creativity and critical thinking (Lai, 2011). Paul and Elder (2006), for example, present creativity and critical thinking as two sides of the same coin. Creativity emphasizes both divergent and convergent thinking (Guilford, 1950) through the process of idea generation and then choosing and developing the best ideas. Critical thinking requires convergent thinking by assessing the strength and appropriateness of each idea through a questioning and perspective-taking process, which, in turn, facilitates evaluation and selection of the best ideas (Vincent-Lancrin et al., 2019). Thus, the notions of creativity and critical thinking are linked by the convergent thinking required by both.

Creativity emphasizes both divergent and convergent thinking (Guilford, 1950) through the process of idea generation and then choosing and developing the best ideas.

In practice, creativity and critical thinking are inextricably linked and develop in parallel (Evans, 2020). For instance, the OECD Centre for Educational Research and Innovation recently completed the project "Fostering and Assessing Creativity and Critical Thinking in Education" (Vincent-Lancrin et al., 2019), which developed a shared professional language for both concepts—creativity and critical thinking—to facilitate the teaching, learning, and formative assessment of these skills. Vincent-Lancrin et al. argue that creativity and critical thinking are distinct but nonetheless related:

In practice, creativity and critical thinking are inextricably linked and develop in parallel (Evans, 2020).

- Both creativity and critical thinking require a certain level of openness and curiosity.
- Both may lead to challenging authority, values, or accepted norms.
- Critical thinking requires scientific integrity; creativity requires discipline and judgment.
- Both pursue the deeper understanding of knowledge and solutions.

As part of this project, OECD constructed domain-general and domain-specific rubrics that operationalize the development of creativity and critical thinking. This operationalization entails four subskills common to both: inquiring, imaging, doing, and reflecting (Vincent-Lancrin et al., 2019, p. 14). Table 2 presents OECD's domain-general and comprehensive rubric on creativity and critical thinking.

Table 2.
OECD Domain-General Rubric on Creativity and Critical Thinking

	CREATIVITY Coming up with new ideas and solutions	CRITICAL THINKING Questioning and evaluating ideas and solutions
INQUIRING	• Feel, empathise, observe, describe relevant experience, knowledge and information • Make connections to other concepts and ideas, integrate other disciplinary perspectives	• Understand context/frame and boundaries of the problem • Identify and question assumptions, check accuracy of facts and interpretations, analyse gaps in knowledge
IMAGINING	• Explore, seek and generate ideas • Stretch and play with unusual, risky or radical ideas	• Identify and review alternative theories and opinions and compare or imagine different perspectives on the problem • Identify strengths and weaknesses of evidence, arguments, claims and beliefs
DOING	• Produce, perform, envision, prototype a product, a solution or a performance in a personally novel way	• Justify a solution or reasoning on logical, ethical or aesthetic criteria/reasoning
REFLECTING	• Reflect and assess the novelty of the chosen solution and of its possible consequences • Reflect and assess the relevance of the chosen solution and of its possible consequences	• Evaluate and acknowledge the uncertainty or limits of the endorsed solution or position • Reflect on the possible bias of one's own perspective compared to other perspectives

Creativity and Problem Solving

Creativity and problem solving often are intertwined. Problem solving is defined as the analysis and solution of new and complex problems (Mayer & Wittrock, 2006). According to Guilford (1977),

> problem solving and creativity are closely related. Creative thinking produces novel outcomes and problem solving involves producing a new response to a new situation, which is a novel outcome. (p. 161)

Like critical thinking, problem solving typically is associated with convergent thinking (Treffinger et al., 2002). Some models of creativity posit that creativity is the result of expertise applied to ill-defined problems (Kozbelt et al., 2010). This is true even for novice learners. For example, the student who creates a mathematical model to solve a real-world problem probably did not make a new discovery in the field of mathematics, but their creative process nonetheless resulted in a problem solution novel to them.

In their report, Assessing 21st Century Skills, the National Research Council (2012) distinguished between creativity and non-routine problem solving. Non-routine problem solving requires "expert thinking to examine a broad span of information, recognize patterns, and narrow the information to reach a diagnosis of the problem" (p. 15). Additionally, non-routine problem solving includes creativity to generate innovative solutions, integrate seemingly unrelated information, and entertain possibilities that others may miss.

Creativity and Complex Communication

Communication is a component of creativity. As described above, elaboration—the ability to fully develop and communicate ideas—is a key subskill in the Torrence Test of Creative Thinking and is one of seven aspects in the ACER (2020) creativity framework. Elaboration entails communicating the richness of an idea's potential to meet a given purpose. It requires a compelling explanation of how a novel, and even implausible, idea potentially could be effective. Elaboration gives substance to an idea, and it is one expression of complex communication.

Creativity and Innovation

Creativity and innovation often are combined as a general success skill or competency (Binkley et al., 2014; National Research Council, 2012). Although the two constructs have many similarities, they differ in important ways. Creativity is the ability, of a person or group, to generate a novel and useful product. Innovation, in contrast, is the process the individual or group uses to convert a creative product into a marketable entity (Fadaee & Obaid Abd Alzahrh, 2014). As Lai (2018) explains, "innovation requires implementing a creative idea and bringing it to fruition, despite organizational constraints and challenges." Because of its roots in business, innovation also includes such considerations as cost effectiveness, demand, and ability to scale.

Creativity and Collaboration

There is ample evidence that creativity is fostered through a collaborative classroom environment and peer collaboration (Davies et al., 2013; Lai, 2020). Creative activity, in turn, can promote greater collaboration (Davies et al., 2013). For example, group brainstorming and problem-solving activities can facilitate students' generation of ideas, where students rely on others' ideas to create new ideas. The strong relationship between creativity and collaboration explains, in part, why the Partnership for 21st Century Skills considers "working creatively with others" as a key subskill of creativity and innovation (Battelle, 2019, p. 4).

There is ample evidence that creativity is fostered through a collaborative classroom environment and peer collaboration.

Is Creativity Domain-Specific or Domain-General?

The domain-specific argument holds that creativity is bounded by a domain's content knowledge, practices, and cross-cutting concepts. For example, a person may be a creative mathematician but not a creative musician. In contrast, the domain-general perspective argues that creative people demonstrate divergent and convergent thinking patterns regardless of discipline. Here, staying with the example, creativity looks the same in both mathematics and music.

What does the research say about this long-standing debate? In short, creativity is both domain-specific and domain-general. For example, the Amusement Park Theoretical model of creativity holds that general factors affect creativity in all

A person's creative ability depends on general abilities associated with the creative process. Abilities such as divergent and convergent thinking, idea synthesis and experimentation, and elaboration vary across individuals; they influence the creative process regardless of domain. Moreover, as a person develops expertise within a particular domain, their ability to demonstrate these skills expands substantially.

domains, while several domain-specific factors influence creative performance in increasingly narrow activities (Baer & Kaufman, 2005; Kaufman & Baer, 2005). Similarly, the Plucker and Beghetto (2004) model affirms that creativity has both specific and general components. In other words, a person's creative ability depends on general abilities associated with the creative process. Abilities such as divergent and convergent thinking, idea synthesis and experimentation, and elaboration vary across individuals; they influence the creative process regardless of domain. Moreover, as a person develops expertise within a particular domain, their ability to demonstrate these skills expands substantially. From this perspective, then, a person can be a creative genius in music but not in mathematics.

DEVELOPMENT

How Do Creativity Skills Develop?

Most studies of creativity take one of two directions: either the study of creative genius or the study of everyday creativity.

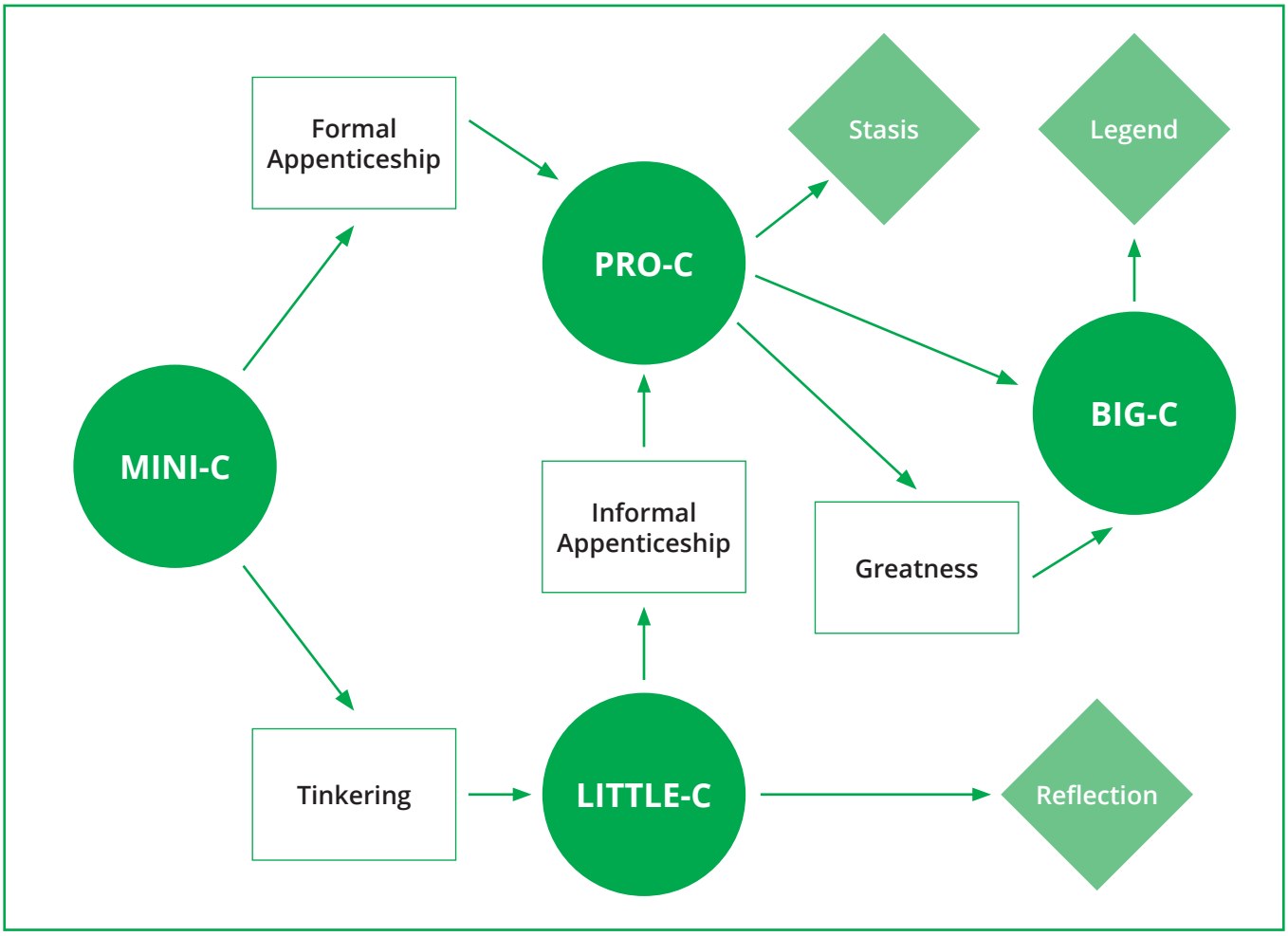
Kaufman and Beghetto (2009) presented a developmental progression of creativity over the lifespan. The 4C Model, as it is called, is a framework for conceptualizing levels of creative expression, and it introduces several potential paths of creative development. In their review of the literature, Kaufman and Beghetto found that most studies of creativity take one of two directions: either the study of creative genius or the study of everyday creativity. Studies of creative genius typically analyze the lives of well-known creators: people who are renowned in their professions or score exceptionally high on creativity measures. Studies of everyday creativity focus on creative activities that the average person might engage in, such as decorating a family room, combining Italian and Chinese food to create a new culinary fusion, or finding a solution to a challenging problem at work. Kaufman and Beghetto contributed to this body of work by proposing four developmental categories of creativity, which are shown in Figure 3 and explained below.

Mini-c Creativity

Everyone begins their creativity development at mini-c, which is defined as the novel and personally meaningful interpretation of experiences, actions, and events (Beghetto & Kaufman, 2007). Mini-c creativity occurs as an individual learns something new. It represents a person's creative process of constructing personal knowledge and accommodating new information to generate new understandings. This view of creativity aligns with Piaget's theory of cognitive development, where individuals construct new knowledge by re-organizing existing mental schemas. According to Kaufman and Beghetto, mini-c creativity is especially important when a school-based professional applies standards to judge creative insights in a K-12 school context. Mini-c creativity expands the definition of creativity so that personally meaningful insights are recognized and credited even when a student may lack experience and domain-expertise or struggle to effectively communicate ideas. With regard to effective communication, evaluation of mini-c creative accomplishments tend to prioritize a person's creative potential over their ability to elaborate and explain newly learned concepts.

Typically, mini-c creativity develops in childhood or when an individual begins to take up a new interest (e.g., an adult having no musical experience who begins piano lessons). Such domain-specific knowledge and skills develop through both formal and informal instruction, practice, and maturation. Mini-c is also evident in adults who take up a new hobby or make experimental attempts to repair or improve something they don't know much about (e.g., the computer programmer who spends her weekend updating the backsplash in her kitchen).

Figure 3:
The 4C Model of Creativity (Kaufman & Beghetto, 2009)



Little-c Creativity

Little-c creativity focuses on activities that non-experts participate in every day. It often develops through a hobby or side venture. For example, people demonstrate little-c creativity when they solve a complex problem at work, spend their weekends painting landscapes, create photographs and exhibits them on a photo-sharing website, or replace parts on their bicycle to create more aerodynamic ride. School-age learners often work at little-c level if they engage in purposeful practice in a subject area or sporting event. Little-c creativity presents itself when a child composes a poem or short story, creates a song during music practice, or finds a better way of positioning his body when preparing to hit a baseball. At little-c, creativity becomes a worthy goal in its own right, regardless of how a product is judged by an external audience.

Little-c recognizes that creative potential is widely distributed across individuals and emphasizes characteristics such as unconventionality, inquisitiveness, imagination, and freedom. Additionally, little-c models of creativity rely to some degree on domain-specific knowledge, personal characteristics, and task motivation (e.g., Amabile, 1996). Examples of personal factors associated with higher levels of little-c creativity include self-discipline, tolerance for ambiguity, and a penchant for risk-taking. Little-c creativity tends to de-emphasize analytic skills, which may explain the low correlation between little-c creativity and measures of IQ.

Pro-c Creativity

Pro-c creativity represents individuals who are "professional" creators—they apply creative thinking in a profession—but who have not reached eminent status. Pro-c creativity is exemplified in the systems model of creativity (Csikszentmihalyi, 1999) in which domain, field, and person work interactively. A person applies creative processes and produces creative products within a domain. The community of practice and its "gatekeepers" judge creative accomplishments according to their relative contributions within a domain or field of study. Often it is not until years later that a person's creative accomplishments are recognized as exceptional or eminent. However, many people do make big and small contributions to a professional field of study over their careers. These domain-specific contributions represent Pro-c creativity. Pro-c is consistent with the concept of expertise acquisition, which suggests that it takes 10 years or 10,000 hours of practice to reach prominence within a field. This level of training typically requires a combination of formal training and years of experimentation and exploration. Those who attain professional-level expertise in a domain are likely to attain Pro-c status. Additionally, people who work in in the professional arts (e.g., artists, actors) may reach Pro-c status even if considered amateurs.

Big-C Creativity

Big-C creativity is reserved for unimpeachable eminence regarding the creative contribution, such as by classical composers (e.g., Beethoven), scientists (e.g., Einstein), Pulitzer Prize winners (e.g., Doris Kearns Goodwin), and historical figures (e.g., Franklin D. Roosevelt). According to Simonton (1997), creative output at the Big-C level typically begins in one's 20s, ascends to an optimum level near 40, and then gradually approaches zero output. However, this trajectory differs across domains; artists, for example, tend to reach prominence earlier than scientists.

The Australian Council for Education Research (Ramalingam et al., 2020) recently proposed a developmental trajectory reflecting the creative-thinking process (Figure 4). This trajectory can be situated within one or more of the categories described in the 4C model (Figure 3). That said, the trajectory perhaps is most useful when applied in traditional learning settings where mini-c and little-c conceptions of creativity dominate. Because individual levels of creativity vary across domains, the ACER developmental trajectory should be considered within a specific domain or area of study.

Figure 4:
Skill Development Levels of Creativity (Ramalingam et al., 2020)

	GENERATION OF IDEAS	EXPERIMENTATION	QUALITY OF IDEAS
	Aspect 1.1 Number of ideas **Aspect 1.2** Range of ideas	**Aspect 2.1** Shifting perspective **Aspect 2.2** Manipulating ideas	**Aspect 3.1** Fitness for purpose **Aspect 3.2** Novelty **Aspect 3.3** Elaboration
High		Learners demonstrate a willingness to experiment, shifting beyond conventional perspectives leading to new possibilities. They question and renegotiate the boundaries of the task to navigate around possible constraints. They test out multiple pathways, even those that seem unlikely. (Aspect 2.1) Learners think flexibly to manipulate elements of the task. They effectively combine elements of a task to allow new possibilities or a different way of thinking about the task. (Aspect 2.2)	Learners develop some original ideas containing concepts less familiar to them beyond their social context. (Aspect 3.2) Learners present ideas that are effective and coherent, fluent and well-elaborated. The elaboration of ideas is substantive, addressing their effectiveness and justifying fitness for purpose. (Aspect 3.3)
Mid High	Learners provide many ideas. (Aspect 1.1) Learners provide a range of ideas that are distinct from one another. (Aspect 1.2)	Learners can shift perspective, thinking about the task/problem in a different way and considering the task/problem from a range of conventional perspectives. They are willing to test out an alternative pathway. (Aspect 2.1) Learners demonstrate some evidence of experimentation, manipulating some of the task elements, or synthesising existing ideas. (Aspect 2.2)	Learners' elaboration of ideas attempts to evaluate effectiveness, and/or justifies fitness for purpose. (Aspect 3.3)
Mid	Learners provide a small number of ideas. (Aspect 1.1) Learners' ideas represent a range of themes. (Aspect 1.2)	Learners' manipulations are mainly routine, limiting exploration to obvious elements of the task, and revisiting the same ideas, rather than generating new ones. (Aspect 2.2)	Learners present ideas that are both practical, and likely to be effective. (Aspect 3.1) Learners present ideas that are obvious or conventional and contain concepts that are already familiar to them. (Aspect 3.2) Learners elaborate their ideas, but without an evaluation of effectiveness, or justification in relation to fitness for purpose. (Aspect 3.3)
Low	Learners provide a limited range of ideas all focusing on the same theme. (Aspect 1.2)	Learners view the task through their single perspective without consideration of what task elements can be changed, or considering alternative perspectives or pathways. (Aspect 2.1) Learners' manipulations of the task elements are limited. (Aspect 2.2)	Learners present ideas that are either practical, or likely to be effective, but not both. (Aspect 3.1) Learners develop their ideas in a limited way without elaboration. (Aspect 3.3)

INSTRUCTION

What Instructional Approaches Facilitate Creativity?

Given the importance of creativity in today's world, educators increasingly recognize the importance of developing students' creative potential.

After reviewing interventions designed to enhance creativity, Henessey and Amabile (1987; also see Amabile, 2020) offered several implications for classroom settings. These can be summarized by the three overarching themes that follow.

Given the importance of creativity in today's world, educators increasingly recognize the importance of developing students' creative potential.

Make Learning Fun

Children are most creative when they are having fun. Toward this end, students should be given choice about how to accomplish learning objectives. Additionally, students should have ample time to reflect and experiment with new ideas. For example, early childhood and elementary-grade teachers can ensure sufficient opportunities for free play with a variety of manipulatives and materials. Older students can be provided time to share, experiment, and reflect on their work by themselves and with others. Additionally, teachers should encourage students to take control of their own learning by generating and experimenting with ideas they can generate on their own, before looking to others for support.

Prioritize Creative Pursuits

Teachers can prioritize creativity by listening to students' interests, affirming their strengths and talents, incorporating students' unique interests in performance tasks, and modeling intrinsic enjoyment of creative pursuits. Teachers can reinforce intrinsic motivation by actively pursuing creativity in their classroom and modeling their own enjoyment of creative pursuits.

Avoid External Rewards and Competition

Research over the past 30 years shows that using external rewards and competition to externally motivate student performance can kill creativity (Amabile, 2020). Additionally, formal evaluation of students' creative pursuits can have similar negative effects. To the extent possible, teachers should minimize summative evaluation of students' creativity and, instead, use narrative feedback and other types of formative assessment.

Research over the past 30 years shows that using external rewards and competition to externally motivate student performance can kill creativity.

An extensive literature review by Cremin and Chappell (2021) began with over 800 articles on creative pedagogies, enacted in formal educational settings across the age span. These researchers ultimately focused on 35 empirical, peer-reviewed studies, many of which were qualitative. While more research clearly is needed to fully understand the impact of these instructional approaches on students' creativity, Cremin and Chappell nonetheless provide helpful, if preliminary, guidance for educators interested in nurturing creativity in the classroom. Below, I summarize seven interrelated features characterizing creative pedagogical practice that the Cremin and Chappel review revealed.

Generating and Exploring Ideas

Generating and exploring ideas was identified in 22 of the 35 studies reviewed and reflects "an open ethos and high degree of acceptance of children's ideas – however unusual or unexpected" (Cremin & Chappell, p.

311). In such classrooms, teachers listened to students' ideas intently and elaborated upon them. They created a secure classroom learning environment in which students felt approval and accepted. In other words, teachers encouraged students to explore ideas in a psychologically safe environment: feeling included, and feeling safe to learn, contribute, and challenge the status quo. In early childhood settings, teachers set aside time for these young learners to explore resources: giving the student time, space and freedom to do "free-thinking" (p. 312). More experienced teachers tended to encourage students interaction with the environment and available resources when generating new ideas. Barriers to generating and exploring ideas included time constraints, structured schedules, curriculum requirements, lecture methods, and use of traditional teaching methods (e.g., drill and repetitive practice using textbooks). Interestingly, teachers often reported a tension between providing structured learning activities and allowing free time for students to generate ideas, think critically, and problem-solve.

Encouraging Autonomy and Agency

Encouraging autonomy and agency emerged in 17 of the 35 studies reviewed. Here, autonomy is when students have opportunities to solve problems on their own, be adventurous and nonconforming, and practice persistence. Teachers who encouraged autonomy prioritized choice and provided time for independent exploration and learning. They also facilitated autonomy through providing hands-on activities, encouraging active-learning strategies and question-asking, and allowing time for students to share their work with others.

To encourage agency, or, "pro-actively exerting power" (p. 314), teachers allowed students to experiment with materials and ideas, test their ideas with others, and build on their observations. In one of the studies reviewed, such teachers prioritized student-centered learning approaches, such as giving students the opportunity to lead activities (see McCammon et al., 2010).

Playfulness

Playfulness surfaced as a central element of creative pedagogies in seven of 35 studies reviewed and was most often observed in early childhood and elementary settings. Hui et al. (2015) saw playfulness as "purposeful play on a mid-way point between spontaneity and freedom, and aims and rules" (Cremin & Chappell, 2021, p. 315). Hui et al. (2015) demonstrated the importance of creativity in two Hong Kong intervention studies. In the first study, teachers infused creative arts and creative drama into early reading instruction by integrating linguistic, dance, music, and visual arts. Students had opportunities to imagine and engage playfully in informal learning environments. In the second study, teachers taught creative-drama learning strategies to five- and six-year-old students in subjects such as Chinese, English, and General Studies. Both studies reported gains in aspects of creative elaboration. In another intervention study (Garaigordobil, 2006), treatment-group students played a variety of games that emphasized cooperation, pretending, and enjoyment, whereas students in the control-group participated in the normal curriculum. The treatment group subsequently demonstrated greater divergent thinking and creativity in drawing, especially for students who had low creativity at the outset.

Problem Solving

Problem solving emerged as central to the creative process in 13 of the 35 studies reviewed. Most studies highlighted teachers motivational use of authentic and real-world problems (e.g., Lasky & Yoon, 2011). Although not all activities involved practical problem solving, most were relevant to student life. For example, Jeffries (2006) had teachers involve outside experts in extended projects, relying on the expert to contextualize an authentic challenge to be explored. Collaborative problem solving surfaced as a key feature in developing ideas and selecting potential solutions. Many studies used problem-based learning approaches, and teachers' questions played a key part in extending learners' exploration of problems. Problems also tended to be open ended and prompted students to share ideas and generate solutions in groups.

Risk Taking

In seven of the 35 studies reviewed, risk taking, making mistakes, and accepting failure emerged as a central factor in the creative process. Teachers encouraged students to experiment with possible solutions and to practice resilience. Gajda et al. (2007) found that teachers' risk acceptance related positively with students' self-expression and ideation. Additionally, Gardiner (2017) reported that scaffolding, where the teacher models how to approach a task and then provides support as needed, was important for students' creative resilience as tasks became increasingly difficult. In the absence of such scaffolding, for example, students often became disengaged in free-writing and solution-finding exercises. Henricksen and Mishra (2015) argued that the willingness of award-winning teachers to experiment and break convention was related to their desire to engage in the creative process by creating open environments where students could learn from their mistakes. Moreover, Smith and Henricksen (2016) held that it is rare for creative ideas to come together on the first try. Thus, acceptance of potential failure and a willingness to persist despite setbacks are important components of engaging in creative practice.

Co-constructing and Collaborating

Co-constructing and collaborating emerged as central themes in the creative process in 19 of the 35 studies reviewed. Co-construction is where teachers and students co-developed curricula or performance tasks; toward this end, teachers collaborated with students, and students collaborated with one another. In classrooms where co-construction was evident, students viewed teachers as learning companions, not controllers of the learning process. Teachers provided scaffolding and direction when needed, and they modeled creative thinking strategies such as divergent and convergent thinking, synthesis, and elaboration. Teachers balanced scaffolding, direction, and modeling with sufficient time and space for students' to practice creativity and explore their ideas. Additionally, teacher-student relationships were seen as fundamental to co-constructive creative pedagogy: Teachers who supported creativity maintained productive collaboration, feedback, rapport, and understanding with students (also see Reilly et al., 2011). Further, they provided critical feedback on projects and ideas while evincing a sense of rapport and care, often through emotional support (also see Menter, 2010).

Teacher Creativity

The creativity of teachers was a theme in seven of the 35 reports. In short, a teacher's creativity served as a model for their students. These teachers modeled thinking aloud and prioritized discussion and critique in their classrooms. They also exhibited an enjoyment of the creative process as they modeled and facilitated discussions. One study (Lilly & Bramwell-Rejskind, 2004) posited that teacher creativity fosters student creativity.

How do Classroom Practices and Interventions Influence Creativity-Related Outcomes

Several meta-analyses examine the impact of environmental settings (Davies, 2013), program interventions (Lai, 2018; Ma, 2006; Scott et al., 2004a, 2004b), and professional development (Cremin & Chappell, 2021) on teachers' practices and student outcomes regarding creativity. Meta-analyses conducted before 2018 found average effect sizes for creativity interventions falling between .24 and .84 standard deviations (Lai, 2018). The largest effect sizes were associated with problem solving (*ES* = *.84*) and divergent thinking (*ES* = *.75*), while smaller effect sizes were reported for performance tasks (*ES* = *.35*) and attitudes and behavior such as reacting to creative ideas and initiating creative efforts (*ES* = *.24*). The most effective interventions emphasized the use of cognitive processes for idea generation, problem-finding strategies, and conceptual combination (synthesizing two or more basic concepts into a higher-order concept). Effective interventions also tended to involve social modeling, cooperative learning, and application of creative strategies (e.g., divergent/convergent thinking) to solve real-world problems. Interventions having smaller effects stressed

"imagery, expressive activities, and imaginative exercises" and used "feedback, instructor encouragement, and unstructured exercises as a basis for training" (Scott et al., 2004b, p. 164). Lai (2018) described five training packages and their mean effects one or more studies (Table 3).

Table 3:
A Table of Training Packages, Descriptions, and Study Effect Sizes

TRAINING PACKAGE	DESCRIPTION	EFFECT SIZE	
		M	SD
The New Directions in Creativity Program (Renzulli, 1973)	Based on Guilford's (1967) Structure-of-Intellect Model; contrasts divergent (identifying as many answers or solutions as possible) and convergent (trying to find the best or right answer) thinking	1.41	0.21
Osborn–Parnes Creative Problem-Solving Program (Osborn, 1963; Parnes, 1967)	Provides instruction in four stages of creative problem-solving: (1) identifying and finding problems; (2) generating solutions; (3) evaluating solutions; (4) elaborating on a solution	0.82	0.58
Khatena's Training Program	Involves instruction and practice in five creative thinking strategies: (1) breaking away from the obvious and commonplace, (2) transposition, (3) analogy, (4) restructuring, and (5) synthesis	0.82	0.61
Purdue Creative Thinking Program (Feldhusen, Speedie, & Treffinger, 1971)	Uses twenty-eight audiotaped lessons to support divergent thinking (fluency, flexibility, originality, and elaboration) through instruction, illustrations, and practice	0.63	0.65
Computer-aided creativity training	Includes a combination of computer graphic technology (manipulating text and graphics) as well as Logo computer programming (identifying problems and choosing or combining information, knowledge, and solutions)	0.61	0.23

Source: Lai (2018), summarizing Ma (2006).

THE MEASUREMENT AND ASSESSMENT OF CREATIVITY

How is Creativity Typically Measured and Assessed?

Before discussing how creativity is measured, I briefly summarize differences between measurement and assessment and the corresponding implications for classroom practice. Treffinger et al. (2002) distinguished between measurement and assessment of creativity in their guide for assessing student creativity. Measurement, they said, refers to the use of instruments or testing procedures to obtain quantitative data related to student achievement. In contrast, assessment is a process of gathering, and reasoning from, evidence to understand students' strengths and weaknesses and, in turn, the implications for instruction. Treffinger et al. (2002) identified several sources for gathering information about creative abilities:

- performance data, such as creative products, recitals, and accomplishments
- self-reported data, such as personal checklists and attitude inventories
- rating scales, such as ratings from teachers and parents
- tests, such as standardized performance-based items

Reliability and validity issues are important to consider when making judgments about student creativity. Reliability is improved by standardizing the test design, administration, and scoring conditions, and also by testing large numbers of students. However, measurement scales tend to define creativity more narrowly (e.g., divergent thinking) than performance-based assessments and include limited representations of the construct. These limitations influence the validity of score interpretations according to a more complete description of creativity. For example, someone might score high on measures of divergent thinking but nonetheless struggle to converge ideas, and, in turn, produce something novel and useful (Bolden et al., 2020). A more holistic understanding of students' creativity abilities and potential will require multiple sources of evidence.

Attempts to assess creativity have been occurring for over a century. Consequently, standardized measures of creativity exist that are both reliable and moderately predictive of creative-thinking processes (Lai, 2018). Additionally, classroom-based assessments are available that elicit evidence of creativity and support formative assessment. Table 4 presents common standardized measures (column 3) and corresponding classroom-based formative assessments (column 4) across four foci presented earlier (Rhodes, 1961). By using a combination of standardized measures and classroom-based assessments, teachers can obtain a holistic picture of a student's creativity and, in turn, support their creative potential.

Standardized measures of creativity exist that are both reliable and moderately predictive of creative-thinking processes.

Table 4.
Examples of Creativity Assessments Using Rhodes' (1961) 4 Ps Framework[1]

Assessment Focus (4 Ps)	Definition	Standardized Measures for Evaluative or Improvement Purposes	Non-Standardized Classroom-Based Assessment Types for Formative Purposes
Person	Personality, behavioral, and dispositional attributes associated with creativity	• Khatena-Torrance Creative Perception Inventory (1976) • Gough's Creative Personality Scale (Gough, 1979) • Openness Scale of the NEO[2] Personality Inventory (Costa et al., 2010)	• Behavioral checklists • self-assessments • Anecdotal records
Process	Observable learning and thinking processes involved in a creative act	• Guilford's Tests of Creativity (Berger & Guilford, 1965) • Alternative Uses Test (Guilford, 1967 • Torrance Tests of Creative Thinking (Goff & Torrance, 2000; Khatena & Torrance, 1988; Torrance, 1981) • Creativity Assessment Packet (Williams, 1993) • Runco's Ideational Behavior Scale (Runco, Plucker, & Lim, 2001)	• Behavioral checklists • Self-assessment • Anecdotal records • Performance-based tasks • Portfolios

[1] Additional examples of standardized measures can be found in Abdullah and Cramond (2017).
[2] Neuroticism, Extroversion, Openness

Product	Something that gets produced through the creative process	• Creative Product Semantic Scale (O'Quin & Besemer, 2006) • SPAF (Reis & Renzulli, 1991) • Consensual Assessment Technique (CAT; Amabile, 1983)	• Standardized measures) • Rubrics • Self-assessments • Peer-assessments
Press	The environment and other social factors that influence the creative process	• Assessing the Climate for Creativity (KEYS; Amabile, Taylor, and Gryskiewicz, 1995) • Creative Climate Questionnaire (Ekvall, 1996) • Creative Environment Perceptions Scale (CEPS; Mayfield & Mayfielf, 2010)	• Checklists of environmental conditions • Self-perception questionnaires. • Standardized measures)

I now unpack Table 4 by describing common measures for assessing creativity, after which I consider useful classroom-based assessments for encouraging and supporting students' creative development.

Standardized Measures of Creativity

I consider standardized measures of creativity within the context of the four assessment foci: person, process, product, and press

Person. Person measures focus on creative personality, behavior, styles, attitudes, and values. Such measures tend to be standardized self-rating scales or third-party (e.g., teacher) ratings of students' past behavior (Kanli, 2020). For example, the Khatena-Torrance Creative Perception Inventory (Khatena & Torrance, 1976) comprises two self-perception tests, "What Kind of Person Are You?" (WKOPAY) and "Something About Myself" (SAM), which measure independent dimensions of the creative personality. Both instruments are designed for children ages of 4-12 and for adults above high school. WKOPAY assesses five personality factors:

- acceptance of authority
- self-confidence
- inquisitiveness
- awareness of others
- disciplined imagination

And SAM assesses six:

- environmental sensitivity
- initiative
- self-strength
- intellectuality
- individuality
- artistry

The Creative Personality Scale (CPS; Gough, 1979) is another example of a creative-personality measure. The CPS comprises items that measure creativity both directly (e.g., individuality, insight, resourcefulness, unconventionality) and through its obverse (e.g., cautiousness, sincerity, suspiciousness). All of these measures (CPS, WKOPAY, and SAM) have been used in many studies of creative personality (Abdullah & Cramond, 2017).

Process. Process measures tend to focus on divergent thinking. For example, the Torrance Tests of Creative Thinking (TTCT; Torrance et al., 2003), which targets the domain of divergent thinking, is one of the most widely used measures of the creative process. The TTCT has two versions: figural and verbal. The figural measure uses three picture-based exercises, and the verbal measure uses six word-based exercises. Figural tasks are scored for fluency, originality, and elaboration,[3] while verbal tasks are scored for fluency, originality, and flexibility. There are other well-established divergent thinking tests, such as the Alternative Uses test (Guilford, 1967).[4] Divergent thinking is only one dimension of creativity, of course, and this dimension therefore should not be considered in isolation to measure creative ability.

Product. Product measures focus on the novelty and usefulness of the creative product and typically rely on "external" assessments, which are assessments completed by an outside observer (e.g., an auditor or district administrator). Examples of external assessments used to assess products include checklists, rubrics, and rating scales. Product measures can also be used to estimate a person's creative productiveness over time. For example, Renzulli (2005) distinguishes between "schoolhouse giftedness"—a type of giftedness typically measured by IQ and other cognitive ability tests (e.g., CoGAT)—and creative-productive giftedness, as when a student composes music, creates works of art, writes novels, designs experiments, creates a unique advertising campaign, and so on. While schoolhouse giftedness is person-related, the latter type of giftedness reflects overall creative production. In research, the two most common ways to assess the creative product is through quantitative measures and the Consensual Assessment Technique (Amabile, 1983; 1996). An example of the former is the Student Product Assessment Form (SPAF; Reis & Renzulli, 1991), which is designed to evaluate students' creative products in gifted programs. The SPAF allows products to be rated across nine traits:

- early statement of purpose
- problem focusing
- level of resources
- diversity of resources
- appropriateness of resources
- logic, sequence, and transition
- action orientation
- audience
- overall assessment (e.g., novelty, usefulness, quality, subject familiarity)

The Consensual Assessment Technique (CAT) evaluates creative products through the agreement of a panel of judges familiar with the content domain. The basic technique for using CAT begins by asking participants to create some product that can be judged. Participants are give the same materials and instructions. Next, experts in the focal domain are asked to independently evaluate the creativity of those products, often using a likert-type scale (e.g., rating from 1.0 to 5.0). Experts are not asked to explain or defend their ratings in any way, and it is important that no instructions be given. The expert judges are simply asked to use their expertise in the focal domain to rate the creativity of the products in relation to one another. Although effective for evaluating product creativity within a particular domain (Abdullah & Cramond, 2017), CAT can be challenging to implement in the school setting. This is because CAT requires 8-10 expert judges to reach

[3] Authors stopped scoring the fluency tasks for flexibility because the scores could not be differentiated from fluency scores (Kim, 2006).
[4] See Treffinger et al. (2002, Table 2, p. 14) for a more complete list of indicators of creativity focused on idea generation and divergent thinking.

acceptable interrater reliability, a number that most schools would find difficult to assemble on a regular basis. That said, CAT often is used to judge products for science fairs, invention conventions, and other types of school-related events (Abdullah & Cramond, 2017).

Press. Press measures focus on the degree to which the individual's environment encourages them to be creative; these measures rely on both external checklists of environmental conditions and environmental ratings by an outside rater who is trained to use the measure. Environments that encourage creativity are psychologically safe; provide opportunities for voice, choice, and agency; value creativity; and encourage the creative process. The Creative Environment Perceptions Scale (CEPS; Mayfield & Mayfield, 2010) is an example of an environmental-press measure. Using a 5-point rating scale, CEPS addresses three components of the environment: (1) organizational support (i.e., the amount of encouragement a person receives for creative endeavors), (2) work characteristics (i.e., how well an assignment's structure and responsibilities promote creativity), and (3) organizational barriers (i.e., how policies and time constraints may hinder creativity). One potential weakness of the CEP is that not enough emphasis is placed on the psychological environment. That is, the psychological environment arguably is more important than the physical environment for facilitating the student's creative potential (Cramond, 2005). Teachers, therefore may find it more effective to focus on promoting psychological safety, fostering intrinsic motivation, and providing structured time for both stimulation and quiet reflection (Cramond, 2005). Nonetheless, districts may find the CEP helpful in identifying organizational and structural factors that could be manipulated to promote creativity in schools and classrooms.

In the paragraphs above, I described standardized measures commonly used to evaluate the creative person, process, product, and press. Standardized measures of creativity may also be useful for evaluating how well school- or classroom-based practices improve students' creative processes. For example:

- A school administers the TTCT at the beginning and end of the school year to examine the effectiveness of a creativity intervention on students' divergent thinking skills.
- A creative-writing teacher uses the SPAF to evaluate the impact of a mindfulness curriculum on students' creative production.
- A mathematics teacher uses one of these standardized measures in an action research project, in which she asks, "Did changes in how I deliver feedback on complex real-world problems influence students' openness to new ideas and experimentation with mathematical concepts?"

In all three examples, the creativity assessment is treated as an outcome; it measures how changes in practice (e.g., a new curriculum or instructional strategy) may influence dimensions of creativity (e.g., divergent and convergent thinking, elaboration). By using more formal measures in these ways, educators may contribute to the field's understanding about how creativity develops across the K-12 grade span.

Classroom-Based Assessment of Creativity

Assessment of creativity should employ multiple measures to holistically understand an individual's or group's creative potential, including both strengths and areas for improvement. Teachers collect and use assessment information–gathered through formal measures (e.g., standardized tests, curriculum-based assessments) and informal sources (e.g., teacher-student interactions, observations) to understand and support students' creative

Assessment of creativity should employ multiple measures to holistically understand an individual's or group's creative potential, including both strengths and areas for improvement.

development. Many classroom-based assessment methods have shown to enhance the creative process (Treffinger et al., 2002).

Questionnaires and surveys. These can be used to quantify the extent to which environmental conditions support students' creativity. Although surveys typically are used for evaluative purposes at the school or classroom level, they also can serve to prompt student self-reflection about how to improve creative thinking or dispositions associated with creativity. These measures also can be used by teachers to inform instruction on dimensions of creativity. For example, surveys can prompt teachers to reflect on questions such "How do my students think creatively," and "What skills and dispositions should they rely on when they engage in the creative process?"

Self- and peer-assessments. These are useful feedback and reflection tools. Through interviews, for example, both teachers and peers can help the student reflect on key creativity processes and dispositions. Interviews provide opportunities for teachers and peers to provide feedback and, further, recommend strategies that students can try for improving creative thinking skills, such as thinking divergently/convergently, experimenting with ideas, and elaborating on details about how something works. Graphic organizers can also be used to scaffold the creative process. Students can use graphic organizers to brainstorm problem solutions, select the best solution, and elaborate on how the solution works and why it is the best option. Journals and logs are another useful tool for documenting behaviors when students are engaged in specific activities or content. Students can review logs to revisit and reflect on prior ideas, brainstorm new ideas, or verbally walk through "what-if" scenarios. They also can evaluate their success in using strategies to think more creatively. For example, a teacher could ask students to reflect on the question, "how did you nurture your creative potential this week?" Further, teachers can provide support through daily or weekly student prompts to promote divergent and convergent thinking (e.g., list as many uses for water as you can think of).

Teacher feedback. Students benefit from regular and timely feedback on their creative thinking processes and dispositions. Teacher feedback, therefore, is an essential element in the formative assessment process and, when delivered effectively, produces greater learning (Black & William; Hattie, 2008; Marzano, Pickering & Pollack, 2001). Effective feedback should be goal-referenced, concrete, actionable, specific and personalized, timely, ongoing, and consistent (Wiggins, 2012). Moreover, because feedback is most effective when it references a well-defined, long-term goal (e.g., developing a novel and useful solution to a specific problem), providing frequent feedback against the goal is essential for improvement.

Teachers can provide effective feedback to students as they engage in the creative process. When a teacher routinely points out creative behaviors and thoughts as they occur, students are more likely to both recognize and internalize those thought processes. Following these observations with specific and timely suggestions can enhance the creative process. Additionally, when teachers show students how to deliver effective feedback, students can, in turn, provide feedback to their peers.

Performance tasks and portfolios of students' work. These are useful for assessing students' application of knowledge and skills to complex, novel problems. Additionally, students can choose how they will demonstrate proficiency with these assessments, which promotes meaningful and authentic engagement and further enhances creativity. These assessments also allow the teacher and peers to provide formative feedback regarding skills associated with creativity, such as critical thinking, collaboration, and problem-solving.

Anecdotal records. These are brief, qualitative descriptions of student behaviors, where the teacher systematically records evidence of skills and dispositions associated with creativity. For example, some teachers will tab sections of a notebook with students' names and then document when a student

demonstrates particular skills. By doing so, teachers will have a rich pool of data for documenting when and how students' demonstrated creativity. Additionally, teachers can work with parents to collaboratively note when their child demonstrates creative behaviors at school and at home.

Behavioral checklists. These enable the teacher to convey to students hard-to-observe creative dispositions such as taking risks, being open to new ideas, embracing ambiguity, practicing resilience, and being curious. Checklists most often are used during, or immediately after, instruction to monitor progress and make instructional or behavioral adjustments. For example, teachers may develop—or ask students to develop—a list of behaviors that could serve as evidence of creativity.

What are the Issues When Assessing Creativity?

Assessment that Inhibits and Supports Creativity

A frequently asked question is "Are assessment and creativity fundamentally at odds?" The answer is no—when it is delivered and used effectively. An assessment's effectiveness in nurturing creativity depends on its intended purpose and use. Assessment tends to suppress creativity when it is used—or perceived to be used—to

A frequently asked question is "Are assessment and creativity fundamentally at odds?" The answer is no—when it is delivered and used effectively.

- influence competition and comparisons among students,
- motivate performance (i.e., using grades to reward or punish), or
- evaluate summatively a student's work product or thinking process.

Using assessments in these ways can cause anxiety, undermining students' motivation and capacity for creativity (Bolden et al., 2020; Henessey & Amabile, 1987). Moreover, high-stakes testing can discourage creativity and creative thinking, especially in low-performing schools (Olivant, 2015). And the pressure to raise scores on such tests can intensify a focus on drill-and-kill skills, influence more traditional and rigid instruction, detract from activities that encourage exploration and discover, and discourage teachers and students from focusing on higher-order skills like critical thinking and problem-solving (Jones et al., 2003; Guthrie, 2002).

Relegating assessment to high-stakes and/or summative purposes leaves little space for creativity to flourish.

Relegating assessment to high-stakes and/or summative purposes leaves little space for creativity to flourish. Teachers who associate assessment only with high-stakes testing and formal grading/reporting tend to resist assessing creativity. Specifically, these teachers may fear that assessment will discourage a student's self-expression, or they may believe creativity is too subjective to assess (Bolden et al., 2020; Lucas et al., 2013). Most educators would agree that accountability and high-stakes testing affect the way teachers teach. Nonetheless, creativity can still thrive in an era of standards-based accountability.

A large body of research shows that formative assessment, or assessment for learning, is a powerful tool for improving instruction and learning (Black &Wiliam, 1998; Hattie, 2008)—and, importantly, for nurturing and enhancing students' creative potential. A recent review of creativity assessment in K-12 education revealed two important findings (Bolden et al., 2020):

- Defining the assessment criteria is essential for supporting and evaluating creativity.
- Self-assessment and reflection are particularly valuable for nurturing creativity.

These findings support prior research on effective feedback and formative assessment (Black & William; Hattie, 2008; Marzano, Pickering & Pollack, 2001), and they are consistent with observations made above. Teachers evoke students' creative potential by using a variety of assessment tools and strategies to (a) provide frequent, descriptive, and detailed feedback and (b) highlight areas of creative strength and opportunities for creative growth.

A large body of research shows that formative assessment, or assessment for learning, is a powerful tool for improving instruction and learning (Black &Wiliam, 1998; Hattie, 2008)—and, importantly, for nurturing and enhancing students' creative potential.

The construct of creativity can be defined and measured in a variety of ways. And as discussed above, accurate assessment of a person's creative potential is intertwined with context; the expectations and evidence used to judge creativity evolves and changes across time and contexts. Therefore, it is not possible to create a sole measure of creativity that can be used for all persons in all contexts and situations to judge creativity. Moreover, it behooves educators to develop or adopt explicit definitions of creativity, and to select a range of creativity assessments that produce holistic evidence and that align to these accepted definitions.

What are the Implications of Research for Assessment Design and Use?

The following implications for assessment design and use are related explicitly to classroom-based assessments. Further, these implications are not limited to creativity assessment, as they apply to other student success skills as well.

Assessment Design

Assessments can be designed to measure targeted dimensions of creativity. The most useful assessments elicit observable evidence and allow students to demonstrate the highest forms of creativity within a content area. Evidence-centered design (ECD) is a process for developing assessments of hard-to-observe constructs like creativity. ECD incorporates validity arguments into the design process, rather than seek validity evidence after administration. ECD views an assessment as an evidence-based argument, using things that students say, do, or create to make inferences about the extent of their knowledge, skills, and abilities (Mislevy & Haertel, 2007). In this way, ECD is especially relevant when designing performance tasks that include creativity as a outcome. Through the ECD process, assessment developers delineate types of evidence—an interrelated set of knowledge, skills, and abilities—known to reflect a construct or competency. This collection of evidence is then structured to reflect the relative importance in demonstrating each competency. Rubrics can be designed to capture the intended evidence (e.g., novelty, usefulness, divergent thinking, experimentation, elaboration), and weight of that evidence, toward measuring the overall competency. Finally, cycles of iteration typically are needed to refine the assessment rubric/measure.

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Additionally, assessment tasks should reflect how context and culture matter. As mentioned above, what is considered creative is bound within a particular social and cultural context. Learning tasks that work well for fostering and assessing student creativity in one context may not work equally well in another (Soland et al., 2013). Attending to cross-cultural validity is critical, although sparse in the literature (Ericikan & Oliveri, 2016). As Soland et al. argue,

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> extra caution is warranted when considering measures of 21st century competencies, particularly interpersonal and intrapersonal competencies, because these may be more culturally and contextually dependent than traditional academic skills. To the extent possible, the validity of scores on a given measure should always be confirmed locally (p. 41).

Given the inter-relationship between context and creativity within and across domains, these cautions hold true for assessing the dispositions, processes, and products associated with creative thinking. The following procedures should be used to examine the cross-cultural comparability of assessments, especially when they are administered to groups of students (OECD, 2021):

Review the test materials for face validity. Face validity is the extent to which what is measured by a test, task, or item is understood similarly by students who speak different languages or represent different cultural groups. Ideally, the assessment should be reviewed by experts in the measurement of creative thinking and who are familiar with the cultural groups being tested. This often happens through committee, in which groups of experts independently evaluate the assessment and then convene to compare judgments. This results in a set of recommendations for improving the assessment's quality. The review should focus on evaluating the assessment to ensure that

- the assessment's language is understood similarly across groups;
- the assessment is unlikely to produce construct-irrelevant variance—score variance that is unrelated to creative ability—by virtue of its language or other design features; and
- the assessment is free of cultural bias.

Conduct cognitive labs. Here, a draft assessment is given to a student who is asked to interact with the test materials out loud. For example, a teacher would ask the student to "read the directions aloud and then talk through what you are thinking as you engage with the task." Cognitive labs are helpful for identifying confusing language, possible bias, and other problems before the assessment is officially administered to others.

Conduct small-scale pilot studies. In such a study, the assessment (reflecting any revisions made after the cognitive labs) is given in at least one classroom for validation purposes. An analysis of the resulting data can reveal whether the assessment's items are performing as intended, both in general and for targeted groups of students. Problematic items are revised before administering to the larger population of students.

Conduct a field trial. The pilot study reveals problems that need to be addressed before scaling the assessment to larger populations of students. The field trial serves to confirm that these problems were indeed addressed by administering the assessment to a larger and representative sample of the target population. This process provides the opportunity to conduct a comprehensive review of the assessment prior to administering to the target population. Analysis of student data or annotations of student work can be conducted to ensure that the assessment is measuring what it is designed to measure and that the results support valid interpretations across racial, ethnic, and other cultural groups.

Applying these procedures is important for ensuring valid interpretations of test results in any case, but particularly where students have different socio-cultural backgrounds.

Assessment Use

There are many challenges associated with the use of assessments regarding 21st Century Skills. First and foremost, there is no clear end of grade-level (or grade-span) standards that define proficiency for any of the success skills, including creativity. All assessment requires a learning framework if assessment is to provide meaningful information aligned to curricular goals. These frameworks identify the overall skills as being basic to more complex over time. There at least are a few research-based learning frameworks of how students demonstrate less- to more-sophisticated forms of creativity, among other success skills (e.g., Lucas et al., 2012; PISA, 2020; Ramalingam et al., 2020). These learning frameworks are analytic and multi-dimensional (typically involving four or five levels of student performance), describe performance in grades K-12, and often are not broken down by grade level.

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Empirically validated learning progressions do not yet exist for 21st Century Skills (i.e., Success Skills). Consequently, it is unclear how students develop competence in the domain of creativity. There are no expected levels of creativity at certain markers in time, nor are there any within or across specific contexts or subjects. It also is unclear what, if anything, becomes more complex over time regarding creativity. For example, is it that a student's divergent and convergent thinking processes grow more sophisticated, or is it that the assessment tasks and disciplinary content to which students apply their creativity become more complex or novel? Is it perhaps a combination of the two?

An additional challenge with assessment use relates to rubrics. Rubrics entail scoring and grading, and grading can have negative effects on learning (Shepard, 2019)—especially for creativity (Amabile, 2020). This is because grading can elicit comparisons among students, which can adversely affect student motivation. For these reasons, I recommend that the language of a rubric not be used. Instead, research-based continua are needed that describe creativity from less to more sophisticated. These continua would be pilot tested on student work in local contexts to evaluate the extent to which they accurately reflect how students across socio-cultural contexts and conditions demonstrate competence in the domain.

These continua also would provide useful, formative information that teachers could use during creative problem-solving activities to guide instruction and provide feedback to students. The pilot testing could determine if the continua provide useful feedback to students, parents, and teachers for instructional purposes. Being given specific behaviors to look for during creative problem-solving activities would help teachers know what skills to teach. Further, students could keep these behaviors in mind as they work to improve their creativity skills. Annotated student work samples from across disciplines and types of assessment tasks would be especially useful in helping teachers recognize markers (i.e., learning milestones) for the essential dimensions of creativity in student work products and artifacts.

CONCLUSION

Extensive research suggests that measuring and assessing creativity is not only possible; it can be used in powerful ways to develop and optimize the creative potential of students.

I synthesized literature across multiple disciplines to conceptualize and describe creativity, report research findings, and discuss the corresponding implications for assessment design and use. Overall, this literature shows creativity to be a multi-dimensional construct that has been considered from different perspectives and disciplines. There is not just one way for a person to be creative, or one set of characteristics that differentiate the creative person. As Treffinger (2009) suggested, rather than "how creative are you?" a more meaningful question is "how are you creative? Individuals vary not only in their level of creativity, but in their style of creativity as well (e.g., Selby et al., 2004). Effective assessment of creativity involves a profile of aptitudes, skills, behaviors, and motivations, which can make assessment of creativity a challenging endeavor, particularly in classroom settings where time is a scarce commodity. Nonetheless, extensive research suggests that measuring and assessing creativity is not only possible; it can be used in powerful ways to develop and optimize the creative potential of students. Doing so requires gathering data from multiple sources to understand the richness and breadth of creativity, in an appropriate context, and for appropriate purposes.

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