Chapter 12
Do We Need a Revolutionary Approach to Bring Creativity into Education?

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Abstract What would it take to build an educational system that truly integrated creativity into the core of its processes? In this chapter, we will explore two different approaches to changing the system. We will look at the idea of an educational revolution, and, in particular, the trajectory of the Quiet Revolution that Torrance EP, Goff K (1989) J Creat Behav 23(2):136–145 discussed in their paper of the same name. In contrast, we will look at what the theory of evolution might tell us about changing a system through a more gradual process.

12.1 Introduction

In 1989, Torrance and Goff wrote a paper entitled, "The Quiet Revolution." The paper outlined what they saw as the paradigm shift that had occurred in educational theory and practice. They identified changes in teaching materials, teaching practices, and even the physical teaching environment. The paper posited a bright future for educational systems and a real shift toward educating children in a style that valued and nurtured their creativity skills.

However, in 2011, Kim published "The Creativity Crisis," a review of student scores on the Torrance Test of Creative Thinking (TTCT) since 1990. Overall, student creativity scores, as measured by the TTCT, had dropped significantly during the previous two decades. More precisely, from 1990 to 2008:

- the decrease in fluency scores was significant;
- the decrease in originality for kindergarteners through third graders was significant;
- the decrease in elaboration was significant; and
- the decrease in creative strengths was significant (Kim, 2011).

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While the TTCT is only one measure of creativity, it leaves us with the question, what happened to the creativity-in-education revolution that seemed to be gaining ground in the 1980s? Was it crushed, did it fizzle, or was it just an illusion?

12.2 The Future Is Here Already – It's Just Not Evenly Distributed

Just as averages in research studies don't tell us anything about specific people, the overall state of the U.S. educational system doesn't describe individual schools. In fact, Torrance and Goff's (1989) view of the transformation of schooling toward creative learning did become a reality in a relatively small number of locations.

These revolutionary locations fall into various categories. Most are private and independent schools, some are charter schools, and a small number are public schools – typically schools for the gifted and talented – that have embraced methods designed to enhance students' creativity skills. Of course, many more 'locations' are simply parents who have left the school system entirely, choosing to educate their children at home. The Quiet Revolution had supporters, but the vast majority of the educational system declined the opportunity to incorporate creativity skills and headed off in a completely different direction.

But what caused this split? Some researchers identified the move to standardized education as the key force that directed mainstream education away from the path of creative educational practices (Beghetto, 2010; Longo, 2010). In essence, we support this view, but we would like to explore the impact of standardized education in more detail. We believe that this is important because the core objective of standardized education is to raise the quality of education for all and reduce the likelihood of the least privileged students falling through the net. We believe this goal is laudable and should be supported. Unfortunately, the move to standardization has had a range of unintended consequences, one of which appears to have been the significant reduction in the probability that creativity will be nurtured in the classroom (Beghetto, 2010; Richards, 2010; Torrance, 1959). Furthermore, students in low-income areas are the most likely to be negatively affected by this shift (Beghetto, 2010).

But what is it about standardization that has created this impact? We suggest three distinct and interrelated factors: testing, content expansion, and the system's reaction to creative behaviors.

12.3 Is Testing to Blame?

> I stood in the hallway with the head administrator of a local inner city charter school. He was sharing with me his frustrations around student engagement. "Let me help you," I entreated him. "I can show your teachers how to use creative learning methods to increase student engagement."
>
> "That would be great," he replied. "Unfortunately, the only thing that is going to keep us open is the numbers on the standardized tests. I don't need them to be creative. I need them to know how to choose the correct answer."

The standards-based reform movement began in the 1980s as a way to identify the information students should know at any given grade level (Jennings, 2012). The objectives included providing equal education opportunities to all students and raising the overall level of performance (McClure, 2005). Raising performance is typically defined by increasingly high scores on tests that don't account for creativity. With the onset of the No Child left Behind Act in 2002, standardized education began to take on a new meaning. Increasingly, the focus became teacher accountability for student test scores. This created a culture of test-driven reform, rather than educational reform (Jennings, 2012). Instead of finding ways to engage students in meaningful learning experiences, teachers were trying to find ways to infiltrate content knowledge and teach students information with the primary goal of passing the test.

So where does creativity fit in with testing? How can we expect students to generate original and useful ideas when they have been trained that there is one right answer? As Longo (2010) pointed out:

> Standardized testing remains a contentious issue in education today, and many argue that it weakens creativity. Scores generated by state assessments are used for political purposes to compare students, institutions, and teachers. Standardized testing has always had a major impact on education, but it now impacts… area[s] in which students have opportunities to display creativity. (p. 55)

Government policies are fairly blunt objects. The authors of any piece of legislation are typically trying their best to achieve an effect across an entire system, which means that the policies are likely to be partly wrong for everyone involved in the system. As the system begins to involve more people, this effect is exacerbated. In the U.S., we have moved from individual districts and communities working to meet the needs of their own students, to states setting the standards, and now, to the federal government establishing standards for every state and community. As the directives and correlative assessments have become more centralized, there is less flexibility for individual districts and schools to meet the specific needs of their own communities.

For example, one public school with whom the second author on this paper has worked has a student population comprised mostly of students whose first language is Spanish. Many of the students had no experience speaking or hearing English before entering the school. The school is brimming with creative energy, led by the exceptionally dedicated principal. Classrooms are vibrant, children are engaged, and creative learning is occurring. When asked about standardized testing, the

principal smiles. “The tests don’t work for our population. We don’t put much weight on these tests because they don’t tell us anything about what our students need. Instead, we have developed our own processes and measurements, and we are seeing steady growth in our students. We have a major focus on creativity.” This school has a certain flexibility that many schools don’t have, because it would be detrimental or impossible to “make” the students take the tests “correctly,” when it is known that they are likely to score poorly for reasons beyond their control. On state rankings, the school would not be highly ranked in terms of standardized test scores. But the experience one has while visiting is in stark contrast to the strict atmosphere in one of the “best” public schools in a more elite area across town. This example illustrates how central government-directed standards often miss the boat for many in the system because of the distinct needs of schools, communities, or regions of the country. Sadly, the move to standardized testing has deflected educators’ attention from meeting individual needs through creative learning, as described by Torrance and Goff (1989), to training students in successful test-taking. The goal of ensuring that the least privileged children are receiving top education is not working if the schools with these children have to deliberately work against the system to support their students.

12.4 Did Content Kill Creativity?

> Technically, there is not enough time to implement all of the curricula that I am supposed to be teaching. Each day, I have to make a forced choice of what I can cut. I have to shave minutes off their playtime because there is just so much to cover. – Kindergarten Teacher

An additional impact of the testing/teacher evaluation combination can be seen in elementary education. To raise test scores, schools have attempted to teach more content, at a higher level, to their elementary children. Given that we have no evidence that modern students learn faster, the result of this change has been to squeeze out other activities to find time to accommodate the additional material. For example, when we look at early childhood education, we see recess and free play being reduced or even eliminated. Studies (cited in Miller and Almon, 2009) have found that:

- Teacher-directed activities, especially instruction in literacy and math skills, are taking up the lion’s share of kindergarten classroom time.
- Standardized testing and preparation for tests are now daily activities in most of the kindergartens studied.
- Free play, or “choice time,” is usually limited to 30 min or less per day. In many classrooms, there is no playtime at all. (p. 25)

In the case of early childhood education, we know that play provides children with the opportunity to problem solve, imagine new ideas, and explore a range of possible answers (Ginsburg, The Committee on Communications, and The Committee on Psychosocial Aspects of Child and Family Health, 2007). These behaviors are

essential for the development of creativity skills. Solving unstructured problems becomes ever more important as one moves upward through the educational system and into the "real world." Having domain knowledge is important, but so is having the time to integrate and explore that knowledge. As children get older, they still need play, but the play takes on different forms. When students have the opportunities to experiment, explore, invent, development, theorize, and make connections in content areas, they are being provided with the types of play and creative learning that are important for the development of problem solving skills.

12.5 Is the System Allergic to Creativity?

"You teach creativity? I am not creative." – Teacher
"Why would you say that?" – Creativity Professor
"Because I am terrible at arts and crafts work." –Teacher
"Have you ever had a student that had an issue you didn't know how to solve? And were you able to solve it?" – Creativity Professor
"Of course. Every day I have a challenge like that!" – Teacher
"Then every day you are creative." – Creativity Professor

Of course, the creativity research community must accept some responsibility for reactions such as the one in the conversation above. Over 50 years ago, Stein (1953) published the paper in which he offered what is now generally accepted as the standard definition of creativity—the generation of novel and useful ideas. However, researchers continue to develop new and often more expansive definitions (as discussed in Runco and Jaeger, 2012). While we strongly support the advancement of the field and understand that definitions are important building blocks on which to construct new theories, it is also the case that the plethora of definitions confuses the teaching community. This problem is amplified by the fact that both teachers and administrators are pressed for time and judged by other criteria. In essence, we as a research community have done a poor job of offering simple, practical guidance to the teaching community. Very few publications (Beghetto, Kaufman, and Baer, 2014; Burnett and Figliotti, 2015; Piirto, 2014; Torrance, 1979a) answer the question, "What should I do during first period on Monday morning that will strengthen my students' creativity skills?" Fortunately, there has been crossover work in the field of gifted education that addresses how to integrate creativity into classroom practices while teaching content (for example, see Smutny, 2009; Smutny, Walker, and Honeck, 2016). In fact, right around the time of the Quiet Revolution paper, Torrance and Safter (1990) wrote that they felt that the move toward creative learning was finally here to stay because of the work that had been done in gifted education:

> …the one thing that I think has made the difference has been the gifted education movement. The minority of people in the movement recognized that the one characteristic common to those who have made breakthroughs in all fields is their creativity; these people have made the difference. In my opinion, this minority has gradually become the majority. Gifted

> education has nurtured the creativity movement until it is now shared by all areas of education. (p. 3)

Unfortunately, this transition from gifted into mainstream didn't happen on a systemic level, and this is where we must examine the reaction of the mainstream teaching community. There is evidence (Scott, 1999; Westby and Dawson, 1995) that teachers see creativity as being associated with disruptive behavior. In a period during which teachers have to cover more content to achieve higher test scores, actively encouraging students to engage in (seemingly) disruptive behavior is unlikely to be a popular option. Any move toward a more creative learning environment is likely to result in more 'disruptive' – that is to say, creative – behavior. Fortunately, researchers Kaufman and Beghetto (2013) introduced the idea of *appropriate creativity*. This provides us with language for talking about creative thinking as a positive set of skills that contribute to learning when framed within the appropriate context.

The educational system is not averse to the development of creativity, but it does have legitimate concerns that make it harder to integrate creativity within its existing processes. Furthermore, there is still a significant issue around providing clear definitions and guidance to practicing teachers so that they can understand what is required of them.

12.6 Is Revolution the Answer?

> "You keep using that word. I do not think it means what you think it means."
> - Inigo Montoya, "The Princess Bride"

Educators are caught between the proverbial rock and hard place. On the one hand, state and federal policymakers are placing educational staff under increasing pressure to achieve acceptable test scores. On the other hand, researchers, industry representatives, and the same state and federal policymakers are demanding that the educational system equip students with a range of twenty-first century skills (Adobe, 2014; National Center on Education and the Economy, 2008; Partnership for 21st Century Skills, 2008; Trilling and Fadel, 2009). One of these frequently cited skills is creativity. Given these seemingly conflicting demands, it wouldn't be surprising if it were the teachers themselves who demanded the revolution. But irrespective of who plays the role of the revolutionary, one must ask what this alternative, "revolutionary" future would resemble.

12.6.1 What Would an Educational Revolution Look Like?

One doesn't have to look far to find people who claim to be engaged in an educational revolution. The internet has enabled some extraordinary improvements in content delivery. The Khan Academy freely streams hundreds of thousands of hours of content to students around the world. Additionally, adaptive software allows sites like the Khan Academy or programs like ALEKS to differentiate their teaching so that the pace of delivery adjusts to the needs of individual students. These examples are novel in some ways and will likely be part of the educational future. But are they revolutionary? Your local librarian might disagree. Free access to knowledge has been available – in some parts of the world – for a long time. The internet undoubtedly nudges this towards ubiquity, but the aforementioned examples do not make up the type of revolution that builds creative thinking skills; instead, they represent new delivery methods for traditional content. Furthermore, we can already see these types of resources being absorbed by the existing educational system. This is one more piece of evidence suggesting that these tools are supporting the current model, which is not a criticism, simply an observation. After all, over time many revolutions end up looking remarkably like the vanquished regime.

What about other seemingly revolutionary approaches to education? Recently, a number of Silicon Valley luminaries have become interested in education. Significant sums have been invested into organizations such as Alt School. Unlike the Khan Academy, Alt School focuses on individualized learning, using iPads and adaptive software, delivered to children in specific physical locations. Class sizes are small, and teachers are presented as learning facilitators rather than instructors.

Is such an organization an indicator of future trends? We would have to dig deeper into the full range of content and learning experiences provided to understand if this type of alternative is truly revolutionary. However, without a significant shift in the depth or nature of content and learning approaches, a scenario where children sit in brightly colored rooms working on iPads to complete personalized assignments specified by teachers may not fit the definition of revolutionary. Even so, an Alt School-type model, at the very least, could make incremental improvements to the immediate experiences of children who find themselves attending school at this juncture of tightened educational practices in the mainstream system. Though this particular solution is taking place in the private sector, we need to take all types of alternatives into consideration in order to test models that ultimately lead to broad-sweeping change.

While technology can be useful in tailoring standardized content toward an individual learner's pace and style, it doesn't always encourage a deeper level of creative thinking. If the internet and its associated software aren't providing a revolution, do truly revolutionary examples of educational systems actually exist? The "democratic schools" offer an entirely different way of structuring education. The Sudbury Valley School is an example of this approach. At Sudbury Valley, the entire structure of the educational process is developed as a partnership among the stakeholders, students included, with the central premise that "each person is

responsible for his or her education" (Gray, 2013, p. 91). In addition to the philosophy of personal responsibility, there are several tenets that differ from traditional schooling:

1. There are no curricula or requirements;
2. Students are not grouped by age and are free to associate with others of any age, including adults; and
3. The school is governed by its community members who choose to participate in the governance (Gray and Chanoff, 1986).

It is run by a School Meeting,

> which includes all students and staff members and operates on a one-person-one-vote basis, regardless of the person's age. This body, which meets once a week, legislates all rules of behavior, hires and fires staff, makes all major decisions about budgetary expenditures, and in general has full responsibility for running the school. (Gray, 2013, p. 89)

Sudbury Valley was founded in 1968, so there have been ample decades to track and study the graduates of the school over time. The growing body of literature (see, for example, Gray, 1993; Gray and Chanoff, 1986; Gray and Feldman, 1997) around this model typically concludes that "graduates have continued to do well in higher education and in their careers, and the great majority of them attribute much of their success to the skills, attitudes, and values they acquired during their years at the school" (Gray, 2013, p. 97).

Do the democratic schools represent the creative learning revolution? On the face of it, they do. Although the term *democratic school* encompasses a number of different types of schools, most of them share principles that come from a radically different philosophy. Democratic schools completely change the power dynamics within the structure, which theoretically allows learning experiences to be meaningful to an individual student, having been driven by that student's choice. This opportunity has offered a potentially life-changing benefit to students who rebel against the coercion, control, or unimportant work they feel they have faced in traditional schools. The freedom that students are given at Sudbury allows them to find what is meaningful to them and, ultimately, move on to success in college and in life (Gray, 2013; Gray and Chanoff, 1986). Gray (2013) wrote, "People who had rebelled against required schoolwork when they had no choice in the matter, before going to Sudbury Valley, were not rebelling against the requirements of college and jobs because these had been their own choices" (p. 95). This supports the idea that meaning is a primary component of creativity, and it is a step in the right direction for students to engage in learning that is meaningful to them. However, if their "choices" are similar to the current overarching educational system (such as sitting with a teacher to complete multiple choice worksheets in language arts, as seen in some schools that have less effectively been modeled after Sudbury Valley), then we end up in the same place as when we think technology is the answer without altering content and methodology.

Even so, an option such as Sudbury represents a radical rethinking of education. If the theory is applied well, with rich, creative learning experiences, it might be one

example of an interesting and truly revolutionary approach. Of course, there are relatively few of these institutions, and an analysis of the longevity of their websites suggests a certain fragility. This is not surprising, given the fact that they are working against the current of educational thought and the move toward further standardization. Nevertheless, democratic schools, along with the more technologically-focused innovations of Khan Academy and Alt School, show that different models are possible. These efforts should be supported and applauded, along with the many, many alternative ideas that are being tested nationwide by those who are responding to the needs in their communities for new and better models to engage students in authentic, twenty-first century learning. Even if these alternatives reach only a small segment of the population, they are testing strategies and providing potential examples that could at some point help the majority of students. Just as Torrance and Sisk (1997) noted that the field of gifted education was housing creativity's best practices until mainstream educators realized their need for them, alternative models being put forth through the application of Design Thinking, the Maker Movement, Project Based Learning, 4.0 and Micro Schools, homeschooling, and other alternatives are valid in establishing new ideas that might stick now or in the future. The question we must address is whether any of these examples provide practical guidance to policy makers, administrators, and educators as to how the mainstream educational system could be changed to incorporate the creativity skills we seek.

The question of guidance for policy makers is very important because revolution, by its very nature, is a highly disruptive act. Students entering the school system 20 years from now would regard the change as an interesting historical fact, but for the students who are caught in the turmoil, the effects could last a lifetime. It is difficult for a large system to turn on a dime, but possible for individual schools, teachers, families, or entrepreneurs to step outside of a system that isn't working for them to create new options. For those that don't have the choice to sidestep the system, educators have a responsibility to invent the future while simultaneously delivering the highest quality education that they can today. As we explored with standardized testing, broad sweeping change on a centralized level is likely to create a disruptive wake for those whose needs aren't met by the new policies. It therefore benefits us to ask: Is it possible to fix the current system? Can we organize education in a way that helps children gain the domain expertise they require as they develop their creative and collaborative capabilities?

12.7 Can We Fix the Current Model?

The move to standardized education has been counterproductive for the development of creativity. The research shows this, the reports from individual teachers show this, and any theoretical analysis of initiative – given what we know about how to stimulate creativity – will also show this. And yet the move to standardization has important and worthwhile objectives. Providing a good standard of education for all children is a fundamental requirement of a modern educational system. If we accept

that the move to standardization has valuable objectives, then 'fixing' the problem by simply rolling back to an earlier time would be unacceptable. Whatever solution we create needs to enhance educational standards for all children and build the creativity skills that are important for the twenty-first century.

But if a mainstream revolution seems to be either impossible or too disruptive to a deeply established system, what about an evolution? Revolution and evolution are often presented as polar opposites. But in reality they are both simply mechanisms for effecting change. Revolution, large or small, involves an abrupt change to the current regime. Evolution, however, involves the development of new structures through the retention of variations that are passed down through subsequent generations. The critical part of this process is that the variations that are retained are the ones that provide the best survival characteristics for the organism. We believe that it would be interesting to explore whether consciously using evolution as an analogy could help us move towards a better system without endangering the 'inhabitants' along the way.

12.7.1 What Would an Evolutionary Approach to Integrating Creativity into Education Look Like?

The relationship between evolution and creativity has been explored by a number of researchers, most notably Campbell (1960), who popularized the concept of Blind Variation and Selective Retention (BVSR), and Simonton (1998, 1999, 2011), who built upon Campbell's work. Campbell (1960) identified three conditions that were necessary, under his model, for the creation of new ideas:

1. "A mechanism for introducing variation;
2. A consistent selection process; and
3. A mechanism for preserving and reproducing the selected variations" (p. 381).

The BVSR model attempts to explain creative thought at an individual level. But could it also provide useful insights at a systemic level? We think it might. Applying the evolutionary analogy to the educational sphere allows us to recast the move to standardized testing in a different light. By defining a specific set of tests and evaluating teachers via their students' test results, the policy makers changed the landscape within the educational environment (selection criteria). Over time, educators changed their behaviors (created variations) and those who produced more successful variations stayed in the profession, while others left, or were asked to leave (selective retention). In essence, by focusing on test results, policy makers were attempting to direct the evolution of systemic behavior.

The concept of cultural evolution is controversial. We are going to sidestep this quite valid academic debate by focusing on a smaller scale. In this case, we are interested in how best practices within a learning environment could be developed and transmitted. In very simple terms, we are asking if evolution theory could help

us understand how new ideas enter the teaching environment, get evaluated, and are retained or amplified. Furthermore, could we apply these principles to shape the development of future systems? In other words, could we direct the evolution of school systems towards more creative ends, and in doing so bring in change without causing excessive disruption?

12.7.2 Directed Evolution

The problem with evolution is that it can be very slow. Of course, slow is a relative term. Bacteria can reproduce at a rapid rate whereas mammals proceed in a more stately fashion. But the length of gestation periods is not the key limiting factor. A more important limitation is the whole idea of the generation of variation being 'blind.' In natural systems cells don't mutate with a specific aim in mind, they just mutate. It is only later that we discover whether the change was helpful, harmful, or neutral. In practical terms, this means evolution explores a myriad of cul-de-sacs before a really beneficial capability is developed. Evolution is therefore a very wasteful process.

Fortunately, applying evolutionary thinking within education doesn't require us to engage in completely blind variation. Decades of creativity research have produced a range of theories that seek to define the attributes of creative individuals, processes, products, and environments. When viewed through an evolutionary lens, these theories provide the basis for both sighted variations and the required fitness functions—sets of criteria that describe the desired characteristics of a solution. Applying a fitness function to any new idea would act like a sieve that allows us to retain those elements that score well on the function, and reject those that don't. It would help us define which attributes we should attempt to maximize, and which to minimize.

Of course, providing ourselves with sighted variation and applying the fitness function in a manner that allows us to a priori optimize each iteration moves us from the realm of evolution into directed evolution. However, before we can rush forward into our rapidly evolving educational utopia, we must first stop to consider whether our theories are really good enough to act as selective filters.

12.7.3 Are We Making Progress?

The process of directed evolution is often compared to trying to reach the highest point on a mountain range when all the peaks are covered in clouds: you can't spot the apex, but you can work out whether you are ascending. The risk is that you may spend a lot of time running to the top of various molehills, rather than up the adjacent mountain. One only knows the limits when further progress results in a descent.

In the context of creativity in education, we must ask what our measures of ascent would be. Given that creativity is usually regarded as a complex, multi-faceted phenomenon, the criteria are likely to reflect this. Let's start by sketching the broad requirements for a suitable fitness function.

It is fundamentally important that any such function should not exclude or de-emphasize the importance of domain expertise. Evidence from the teaching community suggests that creativity and the 3Rs (Reading, [W]Riting, and [A]Rithmetic) are often seen as mutually exclusive objectives (Beghetto, 2010).

Having asserted that our fitness function must honor the need for domain expertise, it is equally important to recognize that knowledge and skill are not enough. They must be supported by the appropriate creativity skills (Amabile, 1996). Therefore, developing creativity skills needs to be given equal weighting in the function. But what could go into this function?

12.8 A New Fitness Function

The new fitness function must comprise a set of criteria that is both intelligible and easy to measure. Without both of those conditions being met, it would be hard to convince the educational community that the fitness function was appropriate and valuable.

For the purposes of this paper, and to enable us to explore the practical applications of this concept, we are going to adopt the Torrance Creativity Skills (1979b). We selected Torrance because of the longevity, specificity, and broad appeal of his work:

1. Torrance (1979b) identified, defined, and developed this set of creativity skills based on the works of Guilford, de Bono, Parnes, and Synectics. The criteria have been applied throughout the decades, and the increasing body of literature on these skills (Catalana, in press; Cramond, 2013; Keller-Mathers, in press; Murdock and Keller-Mathers, 2002, 2008; Torrance, 1979a, b; Torrance and Safter, 1990, 1999) suggests that they appear to be as relevant today as they were when Torrance first proposed them,
2. Torrance (1979b) listed 18 specific skills that he identified in children demonstrating creative thinking. This specificity is important if we are to develop a fitness function that could actually be applied in a consistent manner.
3. These skills have been reliability tested over time through the Torrance Test of Creative Thinking (TTCT) (Cramond, Matthews-Morgan, Bandalos, and Zuo, 2005).

Before examining the Creativity Skills list in more detail, it is important to address a couple of points. First, the skills list only covers a subset of the dimensions one may wish to include when thinking about developing creativity skills. A broader model might incorporate criteria spanning all four areas within the 4Ps model outlined by Rhodes (1961): Person, Process, Product, and Press (or

environment). Equally, it might be more appropriate to develop independent fitness functions for each of the four areas. Second, Torrance's list does not cover domain expertise, and therefore only represents a partial fitness function. However, we don't believe that this is a problem. The standardized testing movement has produced a wide range of domain-specific tests. Combining these with the Torrance skills shouldn't prove to be an insurmountable issue. In fact, the decades of application of Torrance's Incubation Model show that it has been used specifically to integrate the development of such creativity skills with content knowledge (Murdock and Keller-Mathers, 2002, 2008; Torrance, 1979a, b; Torrance and Safter, 1990, 1999). The very premise of the Incubation Model, to which these skills are directly related, is to achieve deeper engagement and more lasting content learning by asking students to think at higher, more creative levels of functioning (Torrance and Safter, 1990). Therefore, it would support the wide range of criteria already in place in the system that evaluates the development of domain expertise.

12.9 What Skills Did Torrance List?

Torrance (1979b) identified 18 skills that he believed were necessary for the development of the creative person. The skills were (Table 12.1).

Some of these skills can be appraised relatively easily. For instance, *produce and consider many alternatives* could easily be tested by counting the number of ideas generated by students. Others, such as *visualize it richly and colorfully*, would require a more subjective assessment. However, for each of the skills it is possible to develop specific metrics to determine whether an individual student or an entire class is climbing 'uphill' or 'downhill' as a result of any variation.

12.10 So, Where Is the Variation?

Up to this point, our discussion of evolutionary thinking has focused on the question of how one would evaluate new ideas for their abilities to develop creativity skills. But where would these new ideas come from? We see three possibilities: random variation, lateral meme transfer (the term used to describe an idea as if it were a gene), and deliberate variation.

1. Random variation, as its name suggests, describes things that happen by chance. Children might discover an interesting way of playing soccer that allows their teacher to hold a discussion of probability, and encourage the students to create new games. Or a student might mispronounce a word, which leads to a class discussion about neologisms and the challenge of inventing new languages. Random variations are unpredictable and could be thought of as being akin to the 'mistakes' that happen when a cell makes a copy of itself. Of course, many of

Table 12.1 Creativity skills

Skill	Definition
Produce and consider many alternatives	Fluency; generating many options.
Be flexible	Generating variety; different categories and perspectives.
Be original	Producing statistically infrequent responses; novel, unique perspectives.
Highlight the essence	Identifying the absolutely essential; focusing on what is important.
Elaborate – but not excessively	Developing details or ideas.
Keep open	Resisting premature closure.
Be aware of emotions	Recognizing emotional cues; understanding through feelings.
Put your ideas in context	Putting information into a larger framework.
Combine and synthesize	Putting new connections together.
Visualize it – richly and colorfully	Using vivid, colorful imagery.
Enjoy and use fantasy	Imagining, playing, and considering the nonexistent.
Make it swing! Make it ring!	Using your full range of senses.
Look at it another way	Seeing from a new or different perspective.
Visualize the inside	Describing the inside of things.
Break through – expand the boundaries	Changing the paradigm; going beyond given requirements.
Let humor flow and use it	Responding to incongruities and surprises using humor.
Get glimpses of the future	Imagining possibilities that do not yet exist.

Adapted from Torrance (1979b)

these variations will be uninteresting and will be quickly forgotten, but some will be retained because the teacher felt that they advanced her domain and creativity objectives.

2. Lateral or horizontal gene transfer describes the process by which two unrelated organisms transfer genetic information. On the face of it, this has no application to our area of interest. But, if we replace genes with memes, we can ask ourselves whether new ideas ever enter the world of education from completely unrelated areas. For instance, have Total Quality Management and Statistical Process Control had any influence on the idea of standardized education? Equally, the concept of 'slick presentations' as exemplified by computer tools such as PowerPoint® are now often found in student work. Websites such as Pinterest, which have attracted a large pool of teachers, offer particularly effective ways of transferring memes between geographically separate organizations.
3. Deliberate variation relates to the ideas that are consciously generated by administrators, teachers, parents, and students. In essence, deliberate variations are the results of asking, "How might we do this better/differently?" Within the mainstream system, that question would be focused on how one might develop

creativity skills in association with domain expertise. This is also where the revolutionary ideas, which we discussed earlier, fit into the overall evolutionary system. They are deliberate attempts to create new models.

These three sources of variations produce ideas that feed into the selective retention and reproduction of the overall evolutionary system.

12.11 Reproduction

Evolution requires reproduction. It is the means through which variation can be inherited, and therefore preserved. So, what is the analog of reproduction in our model? We see two main routes: explicit and tacit knowledge exchange. Both of these topics have been well explored by the knowledge management literature (Nonaka and Takeuchi, 1995). In summary, knowledge can be transmitted in two forms:

1. Explicitly encoding it into policies, books, teacher training courses, etc.; and
2. Demonstrating the knowledge in action that results in the development of tacit knowledge through observation and practice.

With this final piece, we have the basics of our evolutionary mechanism for changing educational systems. In summary, the model has three parts:

1. Administrators define a new fitness function that incorporates both domain expertise and creativity skills.
2. Variability in the system produces new outcomes.
3. Successful variations are retained and shared (reproduced), either as explicit or tacit knowledge.

12.11.1 What Does This Look Like in Practice?

We would like to take two recent examples and use our evolutionary lens to examine how they might help to build creativity in the classroom. Over the last three years, the first author of this paper has been working with Elmwood Franklin School, an independent Pre-K – 8th grade school. While this is a premier educational institution that highly values academics, the school's core values statement, which could be thought of as a meta fitness function, also includes "creative inquiry."

In the school's Reggio Emilia (Edwards, 1993) influenced kindergarten class, students are given an active role in choosing the areas they want to explore. Not bound to standardized testing, an inquiry about volcanoes could lead to a deep learning dive into lava, magma, and volcanic eruptions, without too much concern about staying on a specific script.

The first example involves a curious boy in kindergarten who began playing with a cup of water and markers. The boy realized that if he dipped the tip of the marker into the water, he created a "watercolor." Excited, he quickly reached for more cups, began to fill them with water, and started "testing" multiple colors together to see what they would form. As the rest of the students caught on, they also began creating "watercolors," which led to the whole group discovering which primary colors would create secondary colors. By the end of the afternoon, the room was buzzing with small children discovering various colors together.

From an evolutionary perspective, we would see this as an excellent example of random variation. The teacher set up the open space to explore, and the students made a discovery. The discovery itself was not predetermined, but the nurturing, exploratory environment allowed experimentation and insight to emerge organically. If she had been judging the variation by the fitness function, the teacher could certainly check off the creativity skills *produce and consider many alternatives, look at it another way*, and *visualize it richly and colorfully.*

When examined in isolation, the variation can be seen as moving the learning toward the direction favored by our new fitness function. But isolated changes are not going to produce a creative education system. The question we must ask is: Did the idea 'reproduce?' As far as we can tell, the answer is no. The teachers haven't recorded the activity in any way. It hasn't become part of any lesson plan, and a new teacher who joined the school last year wasn't made aware of the idea. In essence, the variation has died. This isn't necessarily a problem, because the teachers, students, and parents are exploring new ideas all the time. But if the school is interested in building up a stock of effective variations, it might be valuable to put more effort into capturing what works, so that it can be improved each year.

At the opposite end of the same school, you would find an example of deliberate variation. The eighth grade teachers developed a program called the Individually Determined Exploration Area, or IDEA project. This is a creative inquiry assignment that begins with each student generating at least 100 options exploring what he or she is curious about. Students learn various creative problem-solving techniques and converge on individual topics they want to learn more about. Over six months, students work across disciplines, plan, research, create, teach, and produce representational videos around their interests. If they used our fitness function, they would likely check off most of the skills Torrance (1979b) originally described. This project has been 'reproduced' for several years, and the design has been documented. This year, the concept has been expanded to include a wider range of teachers, and newly arrived teachers have also been involved in the project. One might even imagine that teachers leaving for other schools could transplant the ideas into their new environments.

12.12 Conclusion

Theories are only really of value if they enable action. While adopting an evolutionary perspective might be intellectually interesting, we have to confront the question, "What next?" We see four distinct steps in response to this question:

1. Evaluate both domain and creativity expertise;
2. Provide teachers with frameworks for teaching creatively;
3. View education from an ecosystem perspective; and
4. Co-ordinate the collection of effective strategies.

First, selective retention through fitness functions has already changed teachers' behaviors. The profession has become increasingly focused on achieving better test scores. This is an unsurprising result. The system will naturally move towards that which is being selected. Fortunately, this behavior pattern can be used to achieve a more creative educational system. In order to gain any ground whatsoever in making changes to the current system, we must first change the fitness function to include creativity skills within the assessment system. This does not need to be in the form of having a test with right or wrong answers. It could be done through a variety of assessment techniques such as the TTCT, portfolios, journals, projects, and putting the learning into context.

Second, if creativity is included within the fitness function, and domain expertise requirements are not relaxed in any way, then it will be essential to help faculty develop teaching strategies that incorporate both objectives. Mechanisms for teaching creatively, as well as teaching creativity, are available and have been well received. Design Thinking (Buchanan, 1992), Problem Based Learning (Hung, Jonassen, and Liu, 2008), and the Torrance Incubation Model (Torrance and Safter, 1990, 1999) are all excellent examples.

Third, so far, we have presented evolution as something that happens within the school environment, (i.e., teachers, administrators, and students interact and various ideas bubble up, are imported, or are deliberately created). But schools don't operate as isolated entities within a petri dish. Instead, they exist as part of an educational ecosystem (Haydon, 2015; Lichtman, 2014). The ecosystem contains the obvious players: teachers, administrators, students, parents, and products. Additionally, it includes the creative environment, teaching strategies, and outcomes. Each of these elements could be a source of variation, selection, and reproduction. Therefore, school systems must pay conscious attention to the overarching environment in order to take advantage of all the variation that is being constantly created.

Finally, researchers have been in a great debate as to what works and what doesn't. This has stopped us from making any significant progress. Borrowing from the world of medical research, systematic literature reviews in the style of the Cochrane Collaboration, an international effort to collect and coordinate the highest quality medical research projects, could help to narrow the search space by identifying the best 'base camps' from which to start exploring. We need a central hub to work collectively and quickly run prototypes of the ideal learning conditions for creativity skills and domain expertise.

School doesn't have to be a battle between competing objectives. Revolutions, quiet or otherwise, are not the only answer. Instead we can encourage the system to evolve in the direction of greater creativity by defining a fitness function that selects for the attributes we desire. Granted, we also need to stimulate and capture interesting variations, but that isn't a problem because teachers, students, parents and administrators are coming up with new ideas all the time.

Let's work together to evolve an education system fit for the twenty-first century.

References

Adobe. (2014, September). *Seeking creative candidates: Hiring for the future.* Retrieved from: http://wwwimages.adobe.com/content/dam/Adobe/en/education/pdfs/creative-candidates-study-0914.pdf

Amabile, T. (1996). *Creativity in context: Update to the social psychology of creativity*. Boulder, CO: Westview Press.

Beghetto, R. A. (2010). Creativity in the classroom. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 447–463). New York, NY: Cambridge University Press.

Beghetto, R. A., Kaufman, J. C., & Baer, J. (2014). *Teaching for creativity in the common core classroom*. New York, NY: Teachers College Press.

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

Burnett, C., & Figliotti, J. (2015). *Weaving creativity into every strand of your curriculum*. Buffalo, NY: Knowinnovation Inc.

Campbell, D. T. (1960). Blind variation and selective retentions in creative thought as in other knowledge processes. *Psychological Review, 67*(6), 380.

Catalana, S. M. (in press). Lessons with no conclusions: Using the incubation model of teaching and learning to break barriers in the classroom. *Torrance Journal of Applied Creativity, 1*(1).

Cramond, B. (2013). The life and contributions of E. Paul Torrance. In E. Romey (Ed.), *Finding John Galt: People, politics, and practice in gifted education* (pp. 25–31). Charlotte, NC: Information Age Publishing.

Cramond, B., Matthews-Morgan, J., Bandalos, D., & Zuo, L. (2005). A report on the 40-year follow-up of the Torrance Tests of Creative Thinking: Alive and well in the new millennium. *Gifted Child Quarterly, 49*(4), 283–291.

Edwards, C. (1993). *The hundred languages of children: The Reggio Emilia approach to early childhood education*. Norwood, NJ: Ablex Publishing Corporation.

Ginsburg, K. R., The Committee on Communications, & The Committee on Psychosocial Aspects of Child and Family Health. (2007). The importance of play in promoting healthy child development and maintaining strong parent–child bonds. *Pediatrics, 119*, 182–191. doi:10.1542/peds.2006-2697.

Gray, P. (1993). Engaging students' intellects: The immersion approach to critical thinking in psychology instruction. *Teaching of Psychology, 20*, 68–74.

Gray, P. (2013). *Free to learn*. New York, NY: Basic Books.

Gray, P., & Chanoff, D. (1986). Democratic schooling: What happens to young people who have charge of their own education? *American Journal of Education, 94*, 182–213.

Gray, P., & Feldman, J. (1997). Patterns of age mixing and gender mixing among children and adolescents at an ungraded democratic school. *Merrill-Palmer Quarterly, 43*, 67–86.

Haydon, K. P. (2015). What if we view our education system as an ecosystem? In M. K. Culpepper & C. Burnett (Eds.), *Big questions in creativity 2015*. Buffalo, NY: ICSC Press.

Hung, W., Jonassen, D. H., & Liu, R. (2008). Problem-based learning. *Handbook of Research on Educational Communications and Technology, 3*, 485–506.
Jennings, J. (2012). *Reflections on a half-century of school reform: Why have we fallen short and where do we go from here?* Retrieved from http://www.cep-dc.org/cfcontent_file.cfm?Attachment=Jennings%5FPaper%5FReflections%5F1%2E27%2E12%2Epdf
Kaufman, J. C., & Beghetto, R. A. (2013). In praise of Clark Kent: Creative metacognition and the importance of teaching kids when (not) to be creative. *Roeper Review, 35*(3), 155–165.
Keller-Mathers, S. (In press). *The curious classroom: Weaving creativity into content with TIM*. Buffalo, NY: ICSC Press.
Kim, K. H. (2011). The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal, 23*(4), 285–295.
Lichtman, G. (2014). *#EdJourney: A roadmap to the future of education*. San Francisco, CA: John Wiley & Sons.
Longo, C. (2010). Fostering creativity or teaching to the test? Implications of state testing on the delivery of science instruction. *The Clearing House, 83*, 54–57.
McClure, P. (2005). Where standards come from. *Theory Into Practice, 44*(1), 4–10.
Miller, E., & Almon, J. (2009). *Crisis in the kindergarten: Why children need to play in school*. Retrieved from http://www.allianceforchildhood.org/sites/allianceforchildhood.org/files/file/kindergarten_report.pdf
Murdock, M., & Keller-Mathers, S. (2002, Fall). Teaching for creativity: Where there's a will, there's a way. *National Association of Gifted Children Celebrate Creativity Newsletter, 13*(2), 3, 4, 10–12.
Murdock, M., & Keller-Mathers, S. (2008). Teaching and learning creatively with the Torrance Incubation Model: A research and practice update. *International Journal of Creativity and Problem Solving, 18*(2), 11–33.
National Center on Education and the Economy. (2008). *Tough choices or tough times: The report of the new commission on the skills of the American workforce*. San Francisco, CA: Jossey-Bass.
Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. New York, NY: Oxford University Press.
Partnership for 21st Century Skills. (2008). *21st Century skills, education and competitiveness: A resource and policy guide.* Retrieved from http://www.p21.org/storage/documents/21st_century_skills_education_and_competitiveness_guide.pdf
Piirto, J. (2014). *Organic creativity in the classroom: Teaching to intuition in academics and the arts*. Waco, TX: Prufrock Press.
Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan, 42*(7), 305–310.
Richards, R. (2010). Everyday creativity: Process and way of life – Four key issues. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 189–215). New York, NY: Cambridge University Press.
Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal, 24*, 92–96.
Scott, C. L. (1999). Teachers' biases toward creative children. *Creativity Research Journal, 12*(4), 321–328.
Simonton, D. K. (1998). Donald Campbell's model of the creative process: Creativity as blind variation and selective retention. *Journal of Creative Behavior, 32*, 153–158.
Simonton, D. K. (1999). Creativity as blind variation and selective retention: Is the creative process Darwinian? *Psychological Inquiry, 10*(4), 309–328.
Simonton, D. K. (2011). Creativity and discovery as blind variation: Campbell's (1960) BVSR model after the half-century mark. *Review of General Psychology, 15*(2), 158–174.
Smutny, J. F. (Ed.). (2009). *Igniting creativity in gifted learners, K-6*. Thousand Oaks, CA: Corwin.
Smutny, J. F., Walker, S. Y., & Honeck, E. I. (2016). *Teaching gifted children in today's preschool and primary classrooms: Identifying, nurturing, and challenging children ages 4–9*. Minneapolis, MN: Free Spirit Publishing.

Stein, M. I. (1953). Creativity and culture. *Journal of Psychology, 36*, 31–322.
Torrance, E. P. (1959). Current research on the nature of creative talent. *Journal of Counseling Psychology, 6*(4), 309–316.
Torrance, E. P. (1979a). An instructional model for enhancing incubation. *The Journal of Creative Behavior, 13*(1), 23–35.
Torrance, E. P. (1979b). *The search for satori and creativity*. Buffalo, NY: Creative Education Foundation.
Torrance, E. P., & Goff, K. (1989). A quiet revolution. *The Journal of Creative Behavior, 23*(2), 136–145.
Torrance, E. P., & Safter, H. T. (1990). *The incubation model of teaching*. Buffalo, NY: Bearly Limited.
Torrance, E. P., & Safter, H. T. (1999). *Making the creative leap beyond*. Buffalo, NY: Creative Education Foundation.
Torrance, E. P., & Sisk, D. A. (1997). *Gifted and talented children in the regular classroom*. Buffalo, NY: Creative Education Foundation.
Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco, CA: Jossey-Bass.
Westby, E. L., & Dawson, V. L. (1995). Creativity: Asset or burden in the classroom? *Creativity Research Journal, 8*(1), 1–10.