

Twisting knobs and connecting things: Rethinking Technology & Creativity in the 21st Century

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Creativity is not a talent. It is a way of operating

—John Cleese

Creativity is just connecting things

—Steve Jobs

Knobs, knobs everywhere, just vary a knob to think

— Douglas R. Hofstadter

Introduction

One of the challenges of understanding creativity is to understand its inception: where do creative ideas come from? This is an important question, given the resurgence of interest in creativity (Simonton, 2004; Eagleman, 2011; Kandel, 2012). Throughout these columns on topics dealing with creativity and 21st century learning we have been exploring different aspects of creative thinking. For instance, in our most recent column (Mishra, Henriksen, & the Deep-Play Research Group, 2013) we focused on defining creativity and asserted a new (*novel, effective & whole*) way of thinking about what creativity is and what it means. In this article, we consider issues such as, where does creativity come from, and how do creative ideas emerge? In brief, we argue that creativity is not a “magical” process, but rather creative ideas emerge from combining pre-existing ideas and concepts in unique and new ways. Though this may appear to be a simplistic formulation, we suggest

that it is far from that. Creating these novel, effective and whole combinations is unpredictable and requires people to bring together a wide range of background knowledge and experience. It is this breadth of knowledge and experience that allows creative individuals to see novel connections and act on them.

The myth of the creative “spark”

Creativity has often been thought of as an elusive and mystical force – emerging from bursts of insight available only to certain fortunate individuals. During Greco-Roman times creativity was considered a divine trait, over which humans had little or no control. Creative ability was merely mythic inspiration (or even madness) imparted by the gods. Plato, for instance, wrote of the “muse” as being a kind of fickle spirit, whimsically bestowing insights or the gift of creativity to particular individuals (Starko, 2005).

Sternberg and Lubart (1991) note that despite significant progress in the scientific study of creativity, many people still continue to view creativity as being magical in nature—a process that cannot be studied or understood analytically. While the persistence of this myth may be dubious to those of us interested in the empirical study of creativity, examples of this view still abound. For instance, consider Elizabeth Gilbert’s 2009 TED talk (Gilbert, 2009), where she asserted the value such ancient Gre-

co-Roman views, in which creativity didn’t come *from* human beings, but instead came *to* human beings (Starko, 2005). Although she suggested this view, for the most part, as a “protective psychological construct”, it does demonstrate the persistence of the popular myth about creativity as being beyond human control.

By Renaissance times, the general understanding of creativity had evolved somewhat. Creative individuals were no longer seen as objects of luck, fate, or mystical forces, but rather as special or singular people with unique ways of seeing (Kneller, 1965). Creative people were now understood to have certain inherent, intuitive abilities to see and understand what others could not. It was at this time that the word “genius” began to be used for extraordinary individuals as Newton or Leonardo da Vinci (Starko, 2005).

The fundamental problem with all of these views was that they either emphasized creativity as something mysterious and inherent in creative individuals, or they viewed it as being bestowed by some mystical force—in either case conceiving it as something beyond the normal and thus, not amenable to analysis. In contrast, contemporary views argue for a more prosaic perspective towards the creative process—suggesting that creativity, though it may feel mysterious, is not magic, and is not out of the reach of our understanding. Creativity is a way of operating, not merely a given trait. In this view, creativity is the end result of the manner in which human

cognition works—and is available to all people. Finally, as with other human cognitive skills, there is a significant level of variability between individuals, and it can be learned and developed with practice.

The key idea here is that all creativity builds upon things and ideas that already exist, i.e. every creative idea is essentially a derivative work. This idea of “combinatorial creativity” (Ferguson, 2011) suggests that new ideas emerge from permutations, combinations and tweaking of existing ideas. Creativity is pastiche—the result of combining old ideas, or fragments of ideas, tweaking and otherwise modifying them to bring something new into the world.

At some level, this notion is not new, and many artists and creative individuals throughout history have remarked on it. For instance, in his Sonnet 59 Shakespeare doubted the possibility of absolute originality in creative work, writing:

If there be nothing new,
but that which is
Hath been before, how are
our brains beguiled,
Which, labouring for
invention, bear amiss
The second burden of a
former child
(*Shakespeare, trans. 2003*)

Mark Twain echoed a similar idea when he suggested that, “substantially all ideas are second-hand, consciously and unconsciously drawn from a million outside sources...When a great orator makes a great speech you are listening to ten centuries and ten thousand men — but we call it his speech, and really some exceedingly small portion of it is his.” (quoted in Popova, 2012)

So if (as Shakespeare or Mark Twain suggest) creativity is simply the act of drawing from existing sources, or as Steve Jobs said, nothing but “connecting things,” it still begs the question of how this kind of appropriation, modification and re-combination of existing ideas take place? And furthermore, why are some people better at it than others?

Variations on a theme

One way of thinking about how these combinations or re-combinations occur is proposed by cognitive scientist (and polymath) Douglas Hofstadter. Hofstadter suggests that every concept in our mind comes with a range of other hooks or concepts associated with it. In essence, one might consider any particular concept to be a device with knobs (knobs that reflect different changeable aspects or properties of the object). A creative person then works with those knobs to figure out possible variations on the original concept, and to incorporate anything that will produce something novel, effective and/or aesthetically pleasing. In other words, creativity involves “twisting the knobs” on an existing idea or artifact, to create new variations on an existing theme.

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For instance, the idea of the Rubik’s cube would come associated with the ideas (or knobs) of geometric shapes, colors, twisting, puzzles, and so on. It is these “variables” or “knobs” that we can change or manipulate to come with a variation on the Rubik’s cube. In a standard Rubik’s Cube, one of the “knobs” is that of dimensionality. In the original instantiation of the idea, it happens to be set to three (as the standard cube is 3 x 3 x 3) – but this does not have to be so. Other new and interesting variations on the Rubik’s Cube have incorporated different levels of dimensionality (2 x 2 x 2; or

4 x 4 x 4; or even more interestingly 2 x 3 x 3, and other variations), in order to offer more or less complexity in the art of solving the puzzle. Clearly these are nothing but, “variations on the theme.”

Creativity then, is the process of making alterations to, and new combinations with, pre-existing ideas and artifacts, to create something new. It is essentially a way of putting a new spin or twist on that which came before. Of course, there is a great variation in the kinds of “knobs” that people see. Merely twisting the knobs may get you something different than what existed before, but that is no guarantee that what it produces will be creative. It may merely be “different”, and anybody can do something different – the key to creativity is to make something with value and style – something novel, effective and whole, as it were. This requires “seeing” knobs that are not obvious at first glance to the uninitiated or untrained.

For instance, a superficial variation on the Rubik’s cube would be twisting the knob labeled “color” and thus changing the colors of the six faces—replacing them with other colors, photographs or other images. This is a different solution but one would loathe to describe it as being creative in the true sense of the word. A deeper variation could involve “seeing” the cube as being an example of a Platonic solid. Once this knob is identified, it somewhat automatically leads to a range of different twisty puzzles based on other Platonic solids—octahedrons, dodecahedrons, icosahedrons and so on. (See twistypuzzles.com to see just how many variations of the Rubik’s cube have been developed—all created by identifying different “knobs” and varying their settings.)

The crucial idea here of course is “seeing” the right knobs. Once these are identified, creating variations is relatively straightforward. Hofstadter (1985) half facetiously writes that creativity is easy, or as he paraphrased it, “knobs, knobs everywhere, just vary a knob to think!” But the critical factor, or “the crux of creativity,” as it were, “is not just in twisting knobs, but in

spotting them.” (p. 251). Clearly they “are not displayed in a nice, neat little control panel, forevermore unchangeable.” And most importantly the ability to spot the right “knobs” on concepts can vary from individual to individual and from context to context.

On knowing (a lot of different things)

A crucial factor influencing how a concept is understood (and thus how it can be changed or reconfigured) is background knowledge. People with a wider range of knowledge and experience have richer concepts to build on, and hence the potential to see more knobs or possibilities than those with narrower foundations. Again, consider the example of the Rubik’s cube above. Only someone with knowledge of solid geometry would see the cube as being an example of many different Platonic solids. Hence, this particular “knob” and its possible variations are only available given the appropriate knowledge or experience – and the same goes for any concepts or artifacts and their potential connections across disciplines. Additionally, Hofstadter also argues that changing the context can “bring new knobs into play” since it can let you see the concept anew “from various angles” as it were where, “more and more of its knobs are revealed” (Hofstadter, 1985, p. 239).

Simply put, creativity is accessible to those who have a wide range of knowledge and experiences because they use these to guide their observations and ability to see “one thing as something else” (Hofstadter, 1985, p. 239). This, we suggest, is where both “combinatorial creativity” and a wide array of knowledge and experiences (what we have called trans-disciplinary knowledge or thinking) becomes essential to creativity. Trans-disciplinary knowledge provides individuals with the mental resources to “spot new knobs” and see the possibilities for twisting them (or making new connections) that would not be accessible to those without such boundary-breaking knowledge. The trick in developing creative thinkers is to provide people with a rich range of ways of understanding and experiencing

the world, thus enriching the concepts they have. This is where the bringing together of art and design or science and poetry provide multiple hooks, and endless new combinations to fuse together in acts of creativity.

Thus, we argue that combinatorial creativity requires having diverse mental resources to build on. These resources may include personal knowledge bases, interests, and experiences, which allow creative people to manipulate existing works and knowledge to create something new. It is also important to note that individuals significantly differ from each other in their knowledge and experience. This has two implications. First, given this diversity, the connections people make will be idiosyncratic to the individual i.e. people will vary greatly in the kinds of connections they make. Second, given its idiosyncratic nature, it is clear that combinatorial thinking cannot be forced or predicted, it must develop organically, determined and constrained by the unique resources that the individual brings to the creative process.

Creative thinkers tend to create this optimized cerebral “climate” for creativity in very natural ways – by enriching their mental cache of reserves, by means of diverse and eclectic interests, knowledge, and life experiences. In developing interests and skills across disciplines, creative thinkers have a deeper pool of inspiration to dip into. Their existing knowledge and experiences can then fuse together and allow them to envisage new combinations and permutations of ideas.

Let history be the guide

The history of science and technology show us many examples of such ways of thinking. For instance, Charles Darwin is an excellent example of a prepared mind, whose creative genius was sparked by something he was reading for pleasure.

It was Darwin’s rich observational experience of traveling across the world on the *HMS Beagle* that mentally primed him for coming up with the theory of evolution. However a key idea (the idea that species evolved

through a process of random variation and natural selection as they compete for limited resources) came to him while he was engaged in some reading for enjoyment (specifically his reading of Malthus’ *Essay on the Principle of Population*). This is best described by Darwin himself, in his autobiography:

In October 1838, that is, fifteen months after I had begun my systematic inquiry, I happened to read for amusement Malthus on Population, and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable (sic) variations would tend to be preserved, and unfavourable (sic) ones to be destroyed. The results of this would be the formation of a new species. Here, then I had at last got a theory by which to work (Darwin, 1887).

Another compelling example comes from the story of the discovery of penicillin by Alexander Fleming. Fleming, in addition to being a top-notch scientist was also a lover of art and was himself a pretty good painter. He created his own watercolor paintings, as a member of the Chelsea Arts Club, but more importantly he also enjoyed the unconventional experience of painting with living organisms. He created fascinating “paintings” using only bacteria and the colors they developed. He painstakingly placed microbes with diverse organic pigments at different locations on a petri dish—which in time developed into intricate pieces of art—including diverse scenes such as ballerinas, soldiers, mothers and children, and much more (Dunn, 2010). Such paintings were technically challenging because Fleming had to first locate microbes with specific pigments, and then figure out how to inoculate them so that the different species matured at appropriate times to reveal the right colors.

It was a strange anomaly in one of these paintings, an uncharacteristic color and growth, which came to his attention and ultimately led to the discovery of penicillin. What made this discovery possible was not merely his scientific knowledge (though that was certainly important) but also the unique combination of science and art in his life and mind. Other scientists had certainly seen Penicillium developing in their petri dishes before Fleming, but had not noted anything significant and had tossed them out as failures. But Fleming saw what he did because he had developed an “eye for the rare, an artist’s eye” (Dunn, 2010).

Charles Darwin and Alexander Fleming are by no means unique in following a path toward successful creativity through the merging of varied knowledge and experiences. Many other historical accounts by creative minds in any field follow a similar combinatorial path – in which great works or ideas arise when inspiration is created through ideas fusing from different disciplines and experiences (Root-Bernstein, 1999; 2003; Simonton, 2004).

These unique combinations and blending of varied knowledge, experiences, and interests are – as history shows us again and again – excellent catalysts for successful creativity. No creative work occurs in a vacuum, nor does it take place locked within tight disciplinary boundaries. Rather, it occurs through accumulated knowledge and varied inspirations, and one of the best ways to promote such thinking is to prepare the mind for it.

Preparing the mind for creativity

The creative process has never been, and will never be, an easy or straightforward one. So just filling one’s mind or life with knowledge and varied experiences is not necessarily sufficient to engender creative ideas. But it may be necessary. “Chance” as Pasteur famously said, “favors the prepared mind.” Thinking and learning across and between disciplines is a means to optimize the mind for the cross-pollination of knowledge that ultimately leads to creative ideas.

Popova (2012) notes how great creative thinkers have often asserted the importance of a “rich personal micro-culture” that allows them to build new combinations. This “micro-culture” becomes a way of being in the world. Thus creative thought is not talent that is unique to certain individuals, or something given to us from the gods. It is, as John Cleese said, not a talent, but rather a way of operating. By cultivating a matrix of knowledge that draws from different disciplines, and opportunistically or strategically pulling from these diverse ideas, we strengthen our ability to think divergently and to make novel connections.

The deeply individual nature of the process suggests that creativity does not follow a straight and narrow path, and that it cannot be predicted. But creativity *can* be nurtured (Mishra, Fahnoe, Henriksen, & The Deep-Play Research Group, 2012; Mishra, Terry, Henriksen, & The Deep-Play Research Group, 2013). It can be nurtured by offering learners rich experiences with art and science, with open-ended experiences that encourage the making of deeply personal connections across knowledge domains. A complex web of possibilities, paths and unfolding connections is needed to offer productive grounds for creative work. The varied mental resources that are developed in a trans-disciplinary way of thinking are a catalyzing agent for creativity; because they provide opportunities for people to “see” different ideas and possible inspirations, and bring them together in unique combinations.

Conclusion

We began this article with a quote from Steve Jobs’ interview in Wired magazine (Wolf, 1995), where he said that, “creativity is just connecting things.” That said, it is clear that these connections have to be made by a prepared mind, a mind prepared to see the right knobs (a la Hofstadter). Steve Jobs clearly understood this. Note his eloquent Stanford commencement address where he spoke of his diverse background and varied interests, and how they prepared him

for success at Apple (Mishra, Terry, Henriksen, & the Deep-Play Research Group, 2013). He struck a similar note in the Wired magazine interview. After saying “Creativity is just connecting things,” he went on to say:

When you ask creative people how they did something, they feel a little guilty because they didn’t really do it, they just saw something. It seemed obvious to them after a while. That’s because they were able to connect experiences they’ve had and synthesize new things. And the reason they were able to do that was that they’ve had more experiences or they have thought more about their experiences than other people. Unfortunately, that’s too rare a commodity (italics added).

This emphasis on prior experiences reveals how we see the “knobs”, possibilities and options in any creative idea. As Hofstadter said, once we learn to see the world in this manner, creativity is as “easy as falling off a log” (1985, p. 251). And it is this “learning to see” that is of most importance to us, as educators, as we continue to emphasize the value of creativity and seek to nurture it in our students. It is here that the new tools we have today, tools that offer new forms of representation, interaction and visualization become so very important. Steve Jobs goes on to say (speaking of the computer industry, but unfortunately very applicable to education today):

A lot of people in our industry haven’t had very diverse experiences. So they don’t have enough dots to connect, and they end up with very linear solutions without a broad perspective on the problem.

Our task as educators is to provide learners with these diverse experiences to help them develop these broader perspectives that Steve Jobs speaks of. The future demands nothing less.

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