ANDREA S. FOSTER

10. FOSTERING CREATIVITY IN SCIENCE CLASSROOMS

Lessons Learned from a Brigadier General

INTRODUCTION

This case study tells the story of fostering creativity in the science classroom through the lens of a gifted physician and now retired U.S. Army Brigadier General who was "unidentified" as gifted while a student and includes a series of informal interviews that illuminate the participant's formative elementary, middle, and high school and college experiences from 1936–1952. The central purpose of this chapter is to highlight these significant school experiences, the need for early identification of scientific talents, and the building of the necessary foundation for future scientific contributions. The chapter also promises a translation of wisdom into sound pedagogical practices – teaching science as inquiry, problem-based learning, etc… that guarantee the development of creative, gifted, and scientific thinkers, and includes recommendations regarding the specific role of creativity in science classrooms and in the nurturing of gifted children as well as key strategies that can make it all happen.

Elementary teachers shoulder the responsibility of teaching all subjects and provide the inspiration for our next generations to develop the necessary scientific habits of mind such as curiosity, informed scepticism, and openness to new ideas as well as playing a most significant role in establishing a science literate citizenry – Americans who have the capacity to solve critical world problems of today.

While observing and evaluating science teacher candidates in elementary and middle school classrooms in area school districts it has been demonstrated that very little time is left for children to express themselves creatively. More than one third of the school day is dedicated to test preparation which mostly involves completing worksheets and paper pencil benchmark testing. Teacher candidates struggle to negotiate the "ideal" inquiry-based classroom which they experience in the science methods classroom with the "reality" of the public school classroom where the emphasis is on worksheets and tests. They are often frustrated and disillusioned by the pedagogical disparities they face. The paradigm of our schools today must be shifted to make classrooms come alive, particularly at the elementary level, so that children are encouraged to think critically, solve problems, collaborate, and create.

M. K. Demetrikopoulos & J. L. Pecore (Eds.), Interplay of Creativity and Giftedness in Science, 187–200.
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Although there is a current creativity crisis in America, previous eras included the wonderful world of Walt Disney and drawing in Anti-Coloring Books[1] where imagination and blank pages represented a world of endless possibility. Classrooms of today should be places where there are concerted efforts to nurture the creativity of all children, particularly in the sciences. The challenge is to design and model rigorous and relevant science experiences and inventive pedagogies for teaching science that come alive in the elementary and middle school classroom with the hope that prospective elementary and middle school teachers use these strategies with their students, particularly the gifted ones.

This chapter explores the interplay of creativity, science and giftedness by sharing a story of fostering creativity in the science classroom through the lens of a retired U.S. Army Brigadier General, Master American College of Physicians, Professor Emeritus in Internal Medicine from a medical center. I conducted a series of informal interviews about his elementary and middle school experiences from 1936–1945 where he attended public schools in Harlem and a High School specializing in Science in the Bronx. He graduated high school at age 16 and then, at age 20, graduated from Columbia University and entered medical school. His early formal school experiences provided a critical foundation for his future scientific contributions in medicine and offer insights into translating this story of science, creativity, and giftedness into sound pedagogical practices that provide meaningful strategies that promote creativity in science and scientific endeavours in order to develop creative, gifted, and scientific thinkers.

THE CREATIVITY CRISIS IN AMERICA

The July 2010 issue of *Newsweek* pointed out that we are currently in a creativity crisis – American creativity scores are falling. Kyung Hee Kim at the College of William & Mary made this discovery after analysing 300,000 Torrance[2] scores of children and adults. According to Kim, the decrease is very significant, with the most serious decline apparent in children from Kindergarten to sixth grade (Bronson & Merryman, 2010). The potential consequences are far-reaching. The necessity of human ingenuity is unquestionable. They report an IBM poll in which 1,500 CEO's identified creativity as the most essential leadership competency of the future, yet creativity is decreasing among Americans at time when it is most vital to the health of our future. "Creativity is necessary not simply to sustain our nation's economic growth, but also to help solve significant world problems like saving the Gulf of Mexico, bringing peace to Afghanistan, and delivering health care" (p. 45).

So what is to blame for our waning creativity among young school children? Likely culprits have been identified. Some claim it has to do with the number of hours kids spend in front of the television, playing videogames, or downloading music and Apps on their iPhones. Another is the lack of creativity development in our schools. Bronson and Merryman (2010) claim there is no concerted effort to nurture creativity in all children in schools today.

Sir Ken Robinson, an internationally recognized speaker and creativity in education expert, makes an entertaining (and profoundly moving) case for creating an education system that nurtures creativity rather than undermining it. Robinson points out the many ways our schools fail to recognize – much less cultivate—the talents of many brilliant people. "We are educating people out of their creativity," Robinson observes (Robinson, 2007). He points out many ways that our schools fail to recognize the talents of many brilliant people. Robinson claims that our schools are organized around an outdated factory model system where children are processed like automobiles or widgets. The number of children who are diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and are medicated is alarming. He claims that these children, who are living in the most stimulating and exciting time on Earth, are being, "anesthetized." We are using exactly the wrong approaches to educating these children. They should not sedated or 'anesthetized' but, stimulated through the arts or what he calls, "Aesthetic Education" or education in the arts. It is the arts that open up minds to creative thinking and problem solving.

STEM to STEAM

According to President Obama (2011), American 15-year olds rank 21st in science and 25th in math compared to their peers around the world. STEM education (Science, Technology, Engineering, and Math) may be fundamentally flawed. Richardson (2011) suggests STEM proponents should start focusing on creativity, originality, and design thinking. Here's why. The creativity crisis in our schools is not just one-dimensional. The European Union declared 2009 as the Year of Creativity, and Chinese faculty actually laughed when they found out the U.S. education trends were in "standardized curriculum, rote memorization, and nationalized testing."

NASA and Boeing are finding that recent graduates can technically render in two dimensions but can no longer think in three (Richardson, 2011). Also, STEM does not necessarily help create the "New Work" workers that are so highly valued in the evolving global community. In a report on "New Work," the Pew Charitable Trust wrote, "The creative jobs that drive the innovation are now the highest 'value added' jobs in the world – real creators of wealth. If states are going to stay competitive, they have to. develop a work force capable of doing creative work."

The Pew report acknowledges that creativity does not just come from artists. In fact, there are approximately 170 classifications that make up "New Work," which can be grouped into five major categories based on the types of knowledge, skills, and aptitudes needed. They are Creative, Education, Social, Technical, and Strategic. Based on these classifications, STEM appears to account for only one fifth of the training we will need to compete in coming decades.

Interestingly, in a recent study, creative jobs increased in Houston, Texas by 8 percent in the last ten years (11,268 new jobs) and is expected to grow by 7 percent by 2016. Creative businesses in Houston had an economic impact of more than $9.1 billion in 2011 (Glenzer, 2012). Ideal job candidates at these companies must now show they can “think with their hands” by having expertise or a second major in a musical instrument, auto repair, or sculpture. At Stanford, the rediscovery of hands-on learning arose partly from the frustration of engineering, architecture, and design professors who realized that their best students had never taken apart a bicycle or built a model airplane (Richardson, 2011).

STEM must keep up. According to Richardson (2011), “STEM’s biggest flaw is that it continues to shine a bright light on engineering while relegating art and design to a dusty corner” (p. 2). The truth is that our biggest innovations come from both the arts and the sciences. John Maeda, president of the Rhode Island School of Design, hosted a workshop funded by the National Science Foundation to explore ways of turning STEM into STEAM (adding an A for “Arts). Students’ brains need to be trained to think flexibily which can be achieved by engaging our creative potential.

The Lack of Creativity in Schools

The lack of creativity in schools, according to most teachers, stems from pressure to meet curriculum standards. Researchers (Bronson & Merryman, 2010) say creativity should be taken out of the art room and put into the homeroom. The argument that we can’t teach creativity because kids already have too much to learn is a false trade off. Creativity is not about freedom from concrete facts. Rather, fact finding and deep research are vital stages in the creative process. With well-designed pedagogy, and project-based learning, curriculum standards can be met.

Creativity is not just about art projects, it is about the thinking process students use to solve problems in all fields. Bronson and Merryman (2010) suggest that students need problems that require them to first fact-find, and then move to problem finding, idea-finding and then solution-finding. This way, they are using divergent and convergent thinking to arrive at original solutions.

The good news is that students can learn techniques for uncovering and leveraging their creative potential. Schools are essential in helping students learn these techniques. Teachers are key to making this happen.

OLD SCHOOL – THE CASE STUDY

The General, a physician, was married to a Kindergarten teacher and both parents supported his children’s early interest in art, science, and creativity and nurtured these creative interests. They limited their children’s television watching to the moon landing, an occasional Brady Bunch episode, and Walt Disney on Sunday evenings and encouraged their children to explore outside interests and participate in outdoor and physical activities such as Blue Birds, Campfire Girls, swimming, diving, and dance. Their children were always engaged in artistic activities such as watercolour lessons, science projects, special colouring books with blank pages and inspirational prompts to spark creative thinking such as, “You had an amazing dream about the future last night, draw your dream.”

The General had a strong work ethic and would leave early in the morning for the hospital where he took care of his patients and performed the administrative work of running the hospital. He would return home in time for dinner with his family. He and his wife devised a KP duty chart that indicated what their children's roles would be in the pre and post dinner preparation, i.e., setting the table, clearing the dishes, sweeping the floor, loading the dishwasher, etc. with each child given one night off per week. In 1969, he left for a tour in Vietnam leaving his wife with five children under the age of ten. Fortunately, his tour lasted only 10 months and he returned safely to a well-run, organized and happy home – thanks to his wife's excellent parenting and teaching skills. In time he became a Brigadiere General, Chief of Medicine at the age of 41 and Commanding General at an army medical center at the age of 48. Ultimately he became Master of the American College of Physicians and Professor Emeritus from a medical university where he contributed greatly to the profession.

His early school experiences shaped who he eventually would become. They provided a foundation for how he and his wife raised five children to become productive, successful adults. They always led by example. In addition, the stories of his schooling shed light on what works and what does not work when working with gifted children and inspiring gifted children to pursue careers in science. The following pages chronicle his early beginnings and educational journey.

The Kindergarten Clock Story & Early School Experiences – 1936–1945

He was born in 1931 to Italian-American parents in New York City. His father was a painting contractor and his mother a school teacher. His grandfather was an artist who immigrated to New York from Palermo, Sicily at the turn of the century. His ancestors came to America with a commitment to the promise of creating a better life for his future descendants.

During our interviews, I asked him to describe his early school experiences and to identify which teachers (K-College) motivated or inspired his creative thinking and problem solving capacities. I asked him to describe the strategies they used to keep him engaged. I also asked him to identify teachers that did *not* motivate his creativity thinking and problem solving capacities and to describe their approaches to learning. He attended Kindergarten in 1936 and the following is how he describes his first school experience that stifled his thinking. He remembers the following Kindergarten incident.

> My Kindergarten teacher, Mrs. Tweedy would say, 'Do what I tell you to do not what you can do.' I got an F for putting numbers on a clock face that she wanted to remain blank.

The very next day, his mother, a school teacher, stormed into the principal's office with the offending clock paper in hand and demanded that he be promoted to the first grade where, because of this new first grade teacher, he thrived.

> My first grade teacher gave me books to read (3rd and 4th grade readers). Many of these books, she bought and paid for herself so that I could be challenged. She often asked me to read to and explain the hard words to the other kids. She also let me help others in the class with their math problems. I felt empowered. She let me go where I wanted to go. I was given the freedom to explore. I was allowed to orchestrate my own experience. She would ask me what I wanted to do. I was pretty good at long division.

By 5th grade in a Manhattan elementary school, he experienced homogeneous grouping. His teacher divided the class into thirds based on ability level. He was okay with this because he was in the highest ability group and he did not mind helping others.

Rapid Development Classes and Specialized Schools – 1943

In 1943 he attended Junior High School in Harlem. His creativity was continuously being nurtured by his teachers. He was placed in a highly competitive, "Rapid Development Class." At the end of 7th grade students took entrance exams to determine where they would complete their high school experience. The idea was to honor the students' different interests and different capacities for learning. The students were tested to determine which specialized high school they would attend: School of Automotive Trades; School for Law; School of Economics; Brooklyn Technical and Engineering School; School of Performing Arts; George Washington General High school, and Bronx High School of Science. He recalls the following.

> In the 7th grade my teacher encouraged me to write to the Department of the Navy about my idea to put stretcher pods on an auto gyro (the grandfather of the helicopter) to evacuate wounded from the beaches in WW2. I got a letters saying thanks, but my idea was "impractical." (I wish I had saved the letter)

He remembered one Civics teacher who did not cultivate creativity during his Junior High School experience.

> On the other end of the spectrum was a 7th grade civics teacher who had a list of questions daily and required rote answers. There was no discussion. We never went into the creation of our constitution. We just memorized the results. She was mean to anyone who had a poor memory.

In spite of the rigid pedagogy, he tested high in mathematics and science and was admitted to the Bronx High School of Science at the age of thirteen.

Bronx High School of Science – 1945–1948

The Bronx High School of Science was founded in 1938, a few years before he became a student. Bronx Science started with 150 ninth grade students and 250 tenth grade students. In 1946, as a result of the efforts the principal, our faculty, and the Parents' Association, the school became co-ed. The achievements of the school have been many. Its graduates have gone on to success in almost every field, especially in science and mathematics. Many have become prominent in such fields as politics, atomic physics, and medicine, engineering, music and health careers.[3] The following is an excerpt from an electronic interview with him in which he considers the influences on his interest in science.

> For me math provides the basis for science to flourish. They seem inseparable. My 8th grade algebra teacher, brought math into astronomy measurements, engineering accomplishments, etc. He made algebra practical and real. Science really flourished in High School. I went to the Bronx High School of Science where all the pre-med students gravitated. We had the equivalent of 6 years of science curriculum including such visionary course as, "The historical development of modern science," which included biographies of great minds in science. I was immediately impressed that I must question, ask why? And think outside the box. It provided a basis as to how to think for the rest of my life I think the magnet school put me on track. The focus was on learning by application and by the excitement of participation. Memorizing alone is not learning even in math where memory up to a point is a necessity, somewhere along the line new equations need to emerge. Math exemplifies an exact science that ultimately needs creativity to advance. We need curricula to include the word, "Why." Why is the earth round? Not just tell "The earth is round" "Why is our blood pressure 120/70? "Why do we sleep?"

Columbia University and Internship and Residency at Bellevue – 1948–1957

After graduating from Bronx High School of Science at 16, he attended Columbia University and was accepted to medical school at New York University. He completed his internship and residency in Internal Medicine at Bellevue Hospital. At Columbia he expanded and broadened not only his understanding of science but also literature, the arts, philosophy, and economic theory. He became more focused in research science, medicine, and physics.

He recalled a favorite college English composition professor repeated the following to his students every day, "Write from your heart and experience: express yourself and release your creativity!" When asked how creativity should be cultivated among gifted children, he offered the following advice to educators.

> I believe we should encourage gifted children by just letting loose their capability. If a 3rd grader can do 8th grade math – that's what the child should be doing. Actually we need to start formal learning by age 3 and include a foreign language. They track the kids by age 5 or 6 to 3 or 4 tracks. The tracks should allow liberal shifting of students as they progress. By high school we should make available dozens of magnet schools: music and art,

> science, engineering, commerce, academic studies etc. Also vocational high schools such as, electrical, construction trades, medical careers, automotive trades, etc. All would have a basic curriculum embellished by their designated area of accomplishment. The non-gifted and slower students would have the opportunity to achieve on their track. No need to drop out or be left back. They now would have the opportunity to advance to a vocation. They would be looking at a successful future and a sense of accomplishment.

The following excerpt from the Bronson and Merryman (2010) *Newsweek* article on creativity about stability and hardship with regard to nurturing creativity in accomplished adults was shared with him and he was asked to respond to these findings.

> Having studied the childhoods of highly creative people for decades, Claremont Graduate University's Mihaly Csikszentmihalyi and University of Northern Iowa's Gary G. Gute found highly creative adults tended to grow up in families embodying opposites. Parents encouraged uniqueness, yet provided stability. They were highly responsive to kids' needs, yet challenged kids to develop skills. This resulted in a sort of adaptability: in times of anxiousness, clear rules could reduce chaos—yet when kids were bored, they could seek change, too. In the space between anxiety and boredom was where creativity flourished. It's also true that highly creative adults frequently grew up with hardship. Hardship by itself doesn't lead to creativity, but it does force kids to become more flexible—and flexibility helps with creativity.

The General offered the following response regarding the issue of hardship induced creativity and flexibility.

> Hardship can also lead to disaster. We don't know what kind of person rises above hardship or sinks with it. Some kids who are anxious and bored turn to crime, not scholastic creativity. I don't feel you can generalize. In my group in New York, growing up in the depression and WW2, we often said, "What are we going to do today?" Out of the group, we had 4 emeritus professors, one "walkie talkie burglar," a janitor and a CEO of a radio station. Who can predict?

STRATEGIES FOR FOSTERING CREATIVITY IN SCIENCE CLASSROOMS

His insights and experiences can be developed into a philosophy of science teaching that treats all students as potentially gifted. "Although creativity was long considered a gift of a select minority," according to Chrysikou (2012), "Psychologists have now revealed its seeds mental processes, such as decision making, language and memory, that all of us possess" (p. 26). The following section includes a sampling of teaching strategies and practical activities that work for teaching K-12 students about science and university students about science teaching. What is common among these examples is that they are problem driven, emphasize critical thinking, have hands-on experiences and are taught in the context of topics that students confront in their own lives. The following are examples of activities that boost creative problem solving in science classrooms.

It All Begins with a Droodle

When students came into the inner city 6th grade classroom, they would be confronted with a drawing on the chalkboard called a, "Droodle." *Droodles* are both a drawing and a riddle. They are simple, yet complex and can be quite humorous. The idea of a *droodle* is to kick start creative thinking, to warm up the brain to encourage out-of-the-box thinking – even though *droodles* are always constructed inside a box. Children enjoy solving these *droodles.* Often their ideas were far more creative than the answer given in the Roger Price's book of *droodles.*[4] This type of warm up activity provides the necessary mental practice for problem solving and decision making. The following is a sample *droodle*.

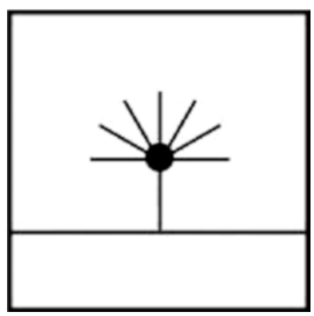

Figure 1. A sample Droodle – A spider performing a handstand

Modeling Inquiry and Teaching that Science Never Sucks with an Egg and a Bottle

An excellent way to inspire problem solving and introduce the inquiry process is to begin the school year with a discrepant event or a simple problem to solve like the classic egg-in-the-bottle demonstration. On the very first day of class, skip the typical syllabus review and dictating of the classroom rules and ask students how to get a hard-boiled egg into an old-fashioned milk bottle without breaking the egg or breaking the bottle. The bottle with the egg can be on top of the teacher's desk as the students come into the classroom. Most students will ask about the egg and the bottle and offer ways to solve the problem like pushing it in and using grease.

Eventually, with guided discussion, students might suggest lighting a match and placing it in the bottle with the egg on the top. When the match burns out, the air in the bottle escapes past the egg and creates a vacuum seal and a pressure differential. The egg appears to be "sucked" into the bottle which is exactly what the students will say. This provides a prime opportunity to help students understand that, "Science doesn't suck!" The egg was actually pushed and pulled by unbalanced force created by the increase of air pressure outside of the bottle. Invite students to then figure out how to get the egg out of the bottle – invert the bottle and blow air past the egg creating another pressure change.

Although the egg and bottle demonstration has been around for a many years, it still has tremendous impact on students' thinking about the science of everyday things. T science teachers have an arsenal of activities to draw from to liven up their classrooms including the work of Bill Nye the Science Guy®, Beakman from Beakman's World®, Sid the Science Kid®, Steve Wolf of Science in the Movies®, and even fictitious yet inspiring, Miss Frizzle®. The engaging works of all these science icons foster creativity in science classrooms.

Creating Science Eyes

Ask any elementary age child what their definition of science is and they will typically respond with something like this, "Science is the opposite of social studies." This response is far too common and the reason for the response, in my view, is tragic. Science, like social studies, in most elementary schools is still being taught opposite social studies. The emphasis on reading and mathematics pushes science and social studies to the end of the day. It is often the case that science is not taught all.

In order to prepare future elementary teachers to teach science, it is absolutely critical to develop ways to inspire teacher candidates to teach science in their classrooms. One approach to doing this is by inviting pre-service teachers to create their own pair of, "Science eyes."[5]

Figure 2 contains a photograph of teacher candidates wearing their newly created science eyes. These science eyes help the teacher candidates inspire their future elementary students to view the world as scientists—to see things in a different light.

Figure 2. Teacher candidates model their Science eyes

Science eyes (Foster, 1994) represent a physical model and a conceptual metaphor for teacher candidates to think through the lens of science and connect science with other subjects such as mathematics, social studies, and language arts as they plan lessons for their students. The act of constructing these creative science eyes helps teacher candidates shift their teaching paradigms to centre teaching and learning around science. Many teacher candidates report that they have their students construct science eyes and wear them during their science lessons to encourage, "Thinking like a scientist."

Project-Based Learning – 21st Century Skills

According to Jones (2012) science lends itself to teaching thinking skills; however, traditional text-based or "cookbook" forms of instruction do not foster scientific habits of mind. What is necessary is a classroom environment where learning strategies, inquiry, real-world, or authentic application, and exploration of relationships of major concepts are the norm.

Critical thinking, collaboration, and communication are three essential 21st century skills. One way to develop these skills is to engage students in Project-based learning (PBL). In Project Based Learning students go through an extended process of inquiry in response to a complex question, problem, or challenge (Pecore, 2015). Rigorous projects help students learn key academic content and practice 21st century skills.

Larmer and Mergendoller (2012) distinguish projects from project-based learning. Projects simply have students apply what they have learned from traditional instruction and; 'main course' project-based learning engages students to learn the material from completing the project. They identify the following attributes of PBL. A 'main course' project:

- Is intended to teach significant content
- Requires critical thinking and problem-solving, collaboration, and various forms of communication
- Requires inquiry as part of the process of learning and creating something new
- Is organized around an open-ended driving question
- Creates a need to know essential content and skills
- Allows some degree of student voice and choice
- Includes processes for revision and reflection
- Involves a public audience

Project-based learning has been at the center of effective science instruction for decades. Project-based learning is a highly effective way of engaging students in authentic problem-based experiences. For example, 7th graders could investigate evidence, from a staged murder in the classroom, to draw reasonable conclusions and learn how to properly use a microscope (Foster, 1995). Prepared evidence bags of hair fibers, an onion, ketchup for blood, and a ransom note were studied by "forensic teams" of students. Students communicated their findings orally and in a written forensic report. Argument and debate among teams were highly encouraged.

In another example, K-College students work in jigsaw (expert and home) groups on an Aquarium Problem in which they use their math skills, and knowledge of fish species, water chemistry, and aquatic plants, to stock a compatible tank of aquarium fish given a particular size tank and a pre-determined budget. Students write persuasive papers and present their solutions to their peers.

Similarly, elementary and middle school children learn about simple machines and Newton's Laws of Motion by exploring the physics of Bobble Head dogs and working in teams to create their own "Shaky Head Thing" using only recycled materials with a "bobability" factor of 5 seconds or more (Foster, 2003).

Classrooms have been transformed into a large human cell with a tarp (blown up with a fan) as a cell membrane and scale models of organelles inside. Students research, build and present their organelles from inside the class cell and then host a, "Cell-a-bration" of learning with parents. Honors Biology students were encouraged to build a museum quality biomes of the world and then invited first graders from a feeder school to tour the converted classroom and learn about biomes.

There really are no limits to creating problem-solving scenarios and driving questions in the classroom that engage students in developing their understanding of science and how they learn about their world. Ideas for projects can be found online, in current events, or they can be invented and created by you or your students. Inviting students to work together, not in homogeneous groups, but in what Fiero (2012) calls, "HeteroGenius," classrooms, is key to ensuring that all children, not just the gifted experience the challenge of learning in our world today and provide leadership opportunities for gifted learners.

C and the Box

The story of *C and the Box* by Frank A. Prince (1993) is a parable and reveals that people must break free of old assumptions and limitations if they want to grow and develop. By exploring outside of a familiar box, C, the leading character, becomes a role model for creativity and imagination, and shows that changing the old way of doing things is necessary for progress. The book is powerful and inspires individuals, particularly teachers, to feel that they can 1) overcome the constraints of conformity and bureaucracy, 2) find new ways to solve problems, 3) discover inner strengths, 4) be creative, and 5) motivate others by example.

LESSONS LEARNED FROM THE GENERAL

The General defines creativity as, "The ability to see things that others do not, particularly in an area that most see as *fait de accompli*,[6] we see it differently." He believes that creativity is intrinsic to the human condition. It comes in different doses and different flavours and we must find ways to unleash the potential for creativity and giftedness in young children. "Find it early and nurture it." His main concern is the lack of a process for identifying creativity and giftedness in

Pre-Kindergarten. Children's thinking must be stimulated early. So if this is the case, then it is imperative that we prepare future EC-6 teacher candidates to recognize the characteristics of gifted young in science and develop best practice "think outside of the box" methodologies to help them inspire our future citizenry to think critically, solve problems creatively and effectively. "Learning itself is a creative process involving thinking, analysing and doing. You don't learn much in a lecture unless you get involved in some way. A lecture may provide the "groundwork" but becomes useless without ultimate challenge, discussion and application. "The essential lessons concerning creativity, giftedness, and science include the following:

- Creativity is intrinsic to the human condition and it must be nurtured.
- Identify gifted young in science at early ages.
- Honour the individual talents and capacities of children.
- Promote Project-based learning as a strategy to inspire creative problem solving and critical thinking.
- Have children work together and let them explore.
- Convergent and divergent thinking are important to creativity and problem solving.
- Focus on effective preparation of future teachers of science, and
- If a child draws the numbers on a blank clock, recognize that there might be some creative potential, encourage it, and of course – do no harm.

Many people assume that creativity is an inborn talent that children either do or do not have; just as all children are not equally intelligent, all children are not equally creative. But, creativity has been demonstrated to be more skill than inborn talent and parents and teachers can help develop this skill. Creativity is essential to success of nearly everything we do and is a key component of health and happiness. Creativity allows people to be more flexible and be better problem solvers, which make them more able to adapt to technological advances and deal with change and take advantage of new opportunities. The key to changing the educational system of today and to shift the paradigm of the worksheet driven, test taking mentality, is to motivate future teachers to be creative, think differently, and be a change agent.

NOTES

1. Susan Striker's Anti-Coloring books for the Young at Art can be found at the following website http://www.susanstriker.com/
2. Torrance Tests of Creative Thinking are considered the 'Gold Standard' in creativity assessments (CQ) that indicates that people who are more creative as children grow up to be more successful than those who are less creative. The Torrrance tests were developed by E. Paul Torrance in the 1950's and 1960's.
3. Some of these individuals are, Harrison Goldin, New York City Comptroller; Oliver Koppel, New York State Assemblyman; Dr. Thomas Matthew, the first Black American neurosurgeon; Leon Cooper, Sheldon Glashow, Roy Glauber, Russell Hulse, David Politzer, Melvin Schwartz, and Steven Weinberg, Nobel Prize Winners in Physics; Harold Brown, Secretary of Defense; E.L. Doctorow and William Safire, authors; and Bobby Darin, a musician.

[4] *Droodles* was a syndicated cartoon feature created by Roger Price and collected in his 1953 book *Droodles*. The trademarked name "Droodle" is a nonsense word suggesting "doodle", "drawing" and "riddle." Their general form is minimal: a square box containing a few abstract pictorial elements with a caption (or several) giving a humorous explanation of the picture's subject. For example, a Droodle depicting three concentric shapes—little circle, medium circle, big square—might have the caption "Aerial view of a cowboy in a Port-a-john." *Droodles* are (or were) purely a form of entertainment like any other nonsense cartoon and appeared in pretty much the same places (newspapers, paperback collections, bathroom walls) during their heyday in the 1950s and 1960s. The commercial success of Price's collections of *Droodles* led to the founding of the publishing house Price-Stern-Sloan, and also to the creation of a Droodles-themed game show.

[5] Seeing things through science eyes: A case study of an exemplary elementary teacher *by Foster, Andrea Susan,* Ph.D., Texas A&M University, 1998, 229 pages; AAT 9903113
Science-eyed elementary teachers exhibit relentless passions for replacing traditional teaching with realistic, integrated, responsible instruction with science at its core. The purpose of this study was to explore an exemplary elementary teacher's thinking about science and how it serves as a vehicle for the learning that occurs in her primary classroom. Two research questions were investigated in this study. First, what does it mean for an exemplary elementary teacher to view all learning with science eyes? Second, in what ways does the science-oriented elementary teacher use her knowledge of science content, pedagogy, and practical experience to structure her students' learning and her classroom teaching?

[6] Etymology. From French *fait accompli* ("an accomplished fact"), from fait ("a fact") accompli ("accomplished"). [edit] Pronunciation. IPA: /ˈfeɪt.əˌkʌm.pli/.

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Andrea S. Foster
Department of Curriculum & Instruction
Sam Houston State University
USA