DOWNLOAD PDF THE SCIENCE AND ART OF BREAKTHOUGHS. INGREDIENTS OF CREATIVITY

Chapter 1 : Old Age and Creativity in Art and Science | HuffPost

Scientific Breakthroughs Rely on Peers. Psychologist Dean Keith Simonton writes in the book "Creativity in Science: Chance, Logic, Genius, and Zeitgeist," that many will read Shakespeare's "Hamlet," and understand at least some of the logic, plot, and character development.

October 11, Getty Images You know what visions I get in my dreams? Visions of falling off of buildings and doing the full body spasm thing when I hit the ground. These 11 people, on the other hand, had dreams that changed the world. The Terminator Does an emotionless cyborg killing machine that looks like Arnold Schwarzenegger seem like a nightmare to you? It was a nightmare for James Cameron. He was fighting a degree fever when a vision of a robot dragging itself along the floor with a knife came to him in his sleep. Apparently Cameron brainstorms best in a dream state: After further investigation revealed that it was a McCartney original, he jotted down some lyrics: Jekyll and Hyde Robert Louis Stevenson had a similar problem: He knew he wanted to write about the dual life of a man, but had no idea how to go about it and was frustrated that no plot was presenting itself to him. Then he closed his eyes. And she has one particularly vivid dream to thank. Meyer wrote her dream down, she said, because it was so different from her everyday, stay-at-home-mom life that she wanted to hold on to it. Lovecraft saw his famous book of the dead in his dreams, including the odd title. Lovecraft had no idea what the odd word meant but scribbled it down anyway. Instead of falling asleep for 17 hours like most sleep deprived people, Mendeleyev dreamt of an arrangement of elements that would change modern chemistry forever, then popped up about 20 minutes later to record it. Awakening, I immediately wrote it down on a piece of paper Only in one place did a correction later seem necessary. After analyzing the dream, the six-time Masters champ realized he was gripping the club differently in the dream than he did in real life. I feel kind of foolish admitting it, but it really happened in a dream. The Sewing Machine Needle Elias Howe, inventor of the modern sewing machine, had been troubled by how to get the needle to work in his new invention. Having the eye at the base as in handheld needles was out of the question. Then, Popular Mechanics reported in , he fell asleep: The king had given him 24 hours to complete the machine and make it sew, but try as he would he could not make the needle work, and finally gave up in despair. At sunrise he was taken out to be executed, and with the mechanical action of the mind in times of great crises he noted that the spears carried by the warriors were pierced near the head. Suddenly, he realized that here was the solution of the sewing machine needle. He begged for timeâ€”and while still begging, awoke. James Watson had a dream that made him consider the double helix. For instance, Kathy Bates breaking your ankle with a sledgehammer. Misery, Stephen King has said, was originally a dream he had on an airplane. But I wrote the first forty or fifty pages right on the landing here, between the ground floor and the first floor of the hotel.

Chapter 2 : Harvey_Seifter. The Art of Science Learning: Fostering Breakthroughs

Creativity takes many forms, but are there characteristics shared by those perceived as geniuses in their chosen domain of art or science? In this highly readable account, Andrew Robinson considers the nature of genius.

Unique undergraduate course shows how imagination informs scientific discovery. At least one student thought that developing a novel recipe for these tasty treats serves as a fine example of how science and art act in harmony. The art came from the personal touches, such as the special mix of spices and decorative icing, which provide the cupcake with a unique taste and appearance. Josh Buoy, a junior in the College of Literature, Science, and the Arts at the University of Michigan, presents a piece of multimedia artwork that reflects the collective creativity of the people in his life. In some cases, like when music instructor and jazz musician Geri Allen talked about the importance of improvisation in both jazz and in her life, the connection between work and creativity seemed obvious. However, as the students and sometimes even Ragsdale surprisingly learn throughout the semester, creativity permeates all manner of academic pursuits, as demonstrated by faculty, from departments like chemistry, physics, history and dance, who have graced the class over the years. In his class, students learn quickly how greatly imagination informs scientific discovery. Atmospheric scientist Sushil Atreya described his work on a NASA mission to send a probe into Jupiter to detect the elements in its core and learn about the nature and origins of the universe. Students also begin to recognize how much planning and precision is required in a work of art, as when poet A. What are the boundaries that scientists today are exploring? An accomplished musician as well as a scientist, Ragsdale knew a lot of individuals in the science and arts departments who could come in as guest speakers, and the class became a big hit. In fact, the class was one of the harder items to leave behind when Ragsdale moved to Michigan with his wife, Ruma Banerjee, in to take on a new position, though he is happy to hear that Berger and NAS member Jim Van Etten have continued running the Nebraska course to great acclaim. When he presented the idea to Tim McKay, head of the honors program at Michigan, he realized that he had found a new home for the course. For example, after each lecture series, the students choose a specific topic from the discussion and write a reflection about that class. The editorial back and forth provides a great opportunity for the students, who, like the speakers, come from a wide range of academic departments, to interact with their peers and learn more about other disciplines. It also prepares them for their culminating course project, in which they creatively expand on a concept presented during the course. Projects have included statistical surveys assessing the role of intuition in a creative work, multimedia investigations of the importance of uncertainty in the creative process, drawings illustrating simplicity or attention, musical compositions exploring the nature of listening, platonic dialogues on the nature of creativity and films depicting giving. Basically, students may develop their projects and reflections in any genre that seems appropriate, including visualizing the concept of harmony through cupcakes. Though Ragsdale initially was unsure if the course in Michigan could match the success it had in Nebraska, he holds no such doubts today. However, he is worried about the loss of intimacy if the format is changed to accommodate more students; furthermore, he already has a full plate managing an active research group and teaching a graduate-level course in critical analysis of the scientific literature.

Chapter 3 : 7 Surprising Facts About Creativity, According To Science

Efforts to cultivate and understand the neurological processes of creativity may mean a more creative generation of scientists with stunning innovations yet to come.

Share Synopsis Why do corporations say they want and need creative ideas, but then reject them when the ideas are ambiguous and make them feel uncertain. Does society really value creativity? People say they want more creative people, more creative ideas and solutions, but do they really? The Greek philosopher Democritus BC promulgated the atomic theory, which asserted that the universe is composed of two elements: Many contemporary historians of the philosophy of science consider Democritus to be the "father of modern science" because of his stunning insight about the universe centuries before our understanding of atomic structure, which did not occur until the early 19th century. All of his ideas were rejected by all of the Greek philosophers and scientists at the time because his beliefs contrasted with those of Aristotle who, according to his followers, was the ultimate authority about the universe. Their commitment to Aristotle and his theories about the universe caused them to feel a great uncertainty in imagining any other possibility. Plato is said to have disliked him and his atomic theory so much that he wished all his books burned. Democritus was ignored by the Athens intellectual community for the rest of his life. Did the ancient Greeks desire creative ideas? They prided themselves for their creativity in the arts, science and society. Yet the rejection of Democritus is just one of many historical examples of breakthrough ideas that were automatically rejected because of their novelty and their nonconformance with existing beliefs which caused a general feeling of uncertainty. For years, they tried to incorporate his view into the established view without success. Interestingly, the skeptical physicists never did accept his theory, instead they eventually died and subsequent generations of physicists who were not prejudiced by the past were able to accept and understand Einstein. What we learn from history is that our established view interferes with our perception and understanding of new ideas and concepts. Do people desire creative ideas and innovation today? Still while most people strongly endorse a positive view of creativity, historians have discovered that scientific institutions, business, education, medical, military, nonprofit, political organizations, and leaders and decision-makers in all fields routinely reject creative ideas much like the Greeks rejected atomic theory. Robert Goddard, the father of modern rocket propulsion, endured ridicule and derision from his contemporary scientific peers who stated his ideas were ludicrous and impossible. The New York Times even chimed in with an editorial written by scientists that Goddard lacked even a high school understanding of rocket propulsion. This example is not unique. We just want to do it. Incidentally, every delivery expert in the U. Office of Patents, said. The device is inherently of no value to us. What use could this company make of an electrical toy? Who would pay for a message sent to nobody in particular? People will soon get tired of staring at a plywood box every night. Zanuck, head of 20th Century Fox, The watches he made consisted of parts each. Frank would handle and inspect each part and think about where it should be placed. Each watch was constructed in a slightly different way which made each watch unique and special. One day, a teacher arrived and taught him a new way of watch making. He showed him how to make watches by categorizing all the parts and putting together subassemblies of about ten elements each in a certain order and each with a certain label. Ten of these subassemblies could be put together into a larger subassembly and a system of ten constituted parts and, eventually a system of groups would constitute the whole watch of parts. He became very efficient and could now make watches in a fraction of the time it took before without much thinking at all. His system of watch making by identity, classification and categorization was carried on by his descendants and became the accepted system of making watches throughout the world. All watches were made the same way and things were good. At first he tried combining the subassemblies in different ways but nothing seemed to work. He gave up and tossed all the subassemblies against the wall where it fell apart into parts. Instead of thinking about improving the watch, he thought about the concept of time and how people throughout history kept track of time and how animals and birds

understood time. Working hard, he created a unique and novel watch. All the watchmakers looked at and thought it was indeed a novel concept. None would accept it so they continued to make watches the way they are supposed to be made. This forced the inventor to start his own company and became the richest man in the world. The above is, of course, a fable. In real life in , the Swiss dominated the world watch industry. The Swiss themselves invented the electronic watch movement at their research institute in Neuchatel, Switzerland. It was rejected by every Swiss watch manufacturer. After all, it was battery powered, did not have bearings or a mainspring and almost no gears. Seiko executives, with no background in the watch industry, took one look at this invention that the Swiss manufacturers rejected at the World Watch Congress that year and took over the world watch market. Once people establish a hypothesis about the way things are, they develop a deeply-rooted bias against anything that causes them to feel uncertain, anxious or confused about their pre-established hypothesis. The novelty of the new watch caused great uncertainty in the minds of the watchmakers. The insidious nature of this bias is that there is strong societal pressure to endorse creativity and its products and a strong social desirability bias against expressing any view of creativity as negative. The resulting state is similar to that identified in research on racial bias; a conflict between an explicit preference towards creativity and unacknowledged negative associations with creativity. So we say we strongly support creativity while routinely rejecting creative ideas and never admitting it. This is because creative ideas are novel and different which makes us feel uncertain and afraid. Michael Michalko is the author of the highly acclaimed Thinkertoys: Putting Your Imagination to Work.

Chapter 4 : Creativity in science

Introduction - 'The science and art of creative breakthoughs' Part I: Ingredients of Creativity 1. Talent, genius, and polymathy 2. Intelligence is not enough 3. The.

Professor of Economics, University of Chicago Old Age and Creativity in Art and Science One of the most widespread and persistent myths about creativity is that it is the domain of the young. Guggenheim Museum has chosen colors to match from its collections and galleries in a new partnership with Fine Paints of Europe. The colors are not named or identified as being from a particular painting because they have been taken out of that context, said Karen Meyerhoff, managing director for business development at the Guggenheim. Guggenheim Museum, New York One of the most widespread and persistent myths about creativity is that it is the domain of the young. So for example in surveying popular attitudes toward aging, the psychologist Dean Simonton observed that "Most conspicuous is the notion that creativity is the prerogative of youth, that aging is synonymous with a decrement in the capacity for generating and accepting innovations. In the single most ambitious empirical study of the relation between age and achievement, the psychologist Harvey Lehman concluded in that "the genius does not function equally well throughout the years of adulthood. Superior creativity rises relatively rapidly to a maximum which occurs usually in the thirties and then falls off slowly. Greater knowledge, and associated entrenched habits of thought, do appear to constrain conceptual innovation. One reason for this is that they create barriers for the radical simplifications that often characterize conceptual creativity: In your letter you speak of my realization in art. I believe that I attain it more every day, although a bit laboriously. Because if the strong feeling for nature - and certainly I have that vividly - is the necessary basis for all artistic conception At the age of 62, Charles Darwin wrote to his youngest son, encouraging him in his college studies. The boy was not a distinguished student, and Darwin, who similarly had not excelled at school, clearly identified with him. He stressed that innovation did not depend simply on intelligence: I have been speculating last night what makes a man a discoverer of unexpected things, and a most perplexing problem it is. Many men who are very clever - much cleverer than discoverers - never originate anything. As far as I can conjecture, the art consists in habitually searching for causes or meaning This implies sharp observation and requires as much knowledge as possible of the subject investigated. In dismissing age as a source of creativity, Lehman, Simonton, and many other psychologists were guilty of taking a part of creativity for the whole. Old age and experience may be lethal for the creativity of conceptual young geniuses, but they are the lifeblood of the innovations of experimental old masters. Among these was Louise Bourgeois, a great experimental sculptor, who once declared "I am a long-distance runner. It takes me years and years and years to produce what I do. When she was 84, and an interviewer asked whether she could have made one of her recent works earlier in her career, she replied, "Absolutely not.

Chapter 5 : Explore the Role of Creativity in Science

The science involved testing hypotheses about the proper blending of various ingredients (fats, sweeteners, flour, eggs, leaveners, flavorings, etc.) that react upon heating to create an edible piece of art with the proper shape, texture and taste.

Other How creativity powers science Some of the best ideas come not from poring over the facts but from a walk in the woods Jennifer Cutraro May 24, â€" 2: Many people figure out creative, new ways to solve problems by allowing their minds to wander. But what about a Nobel prizeâ€"winning chemist? Or a team of engineers that figures out how to make a car engine operate more efficiently? Creativity, it turns out, is not only the domain of painters, singers and playwrights, says Robert DeHaan, a retired Emory University cell biologist who now studies how to teach creative thinking. Or, DeHaan says, it can mean dreaming up a solution to a challenge encountered in the lab. That approach to learning about science, however, emphasizes only facts and concepts. It leaves little room for the creative thinking central to science, Wallace says. In other words, they develop ideas that are both new and useful â€" the very definition of creativity. The process runs counter to what most people would expect to do when tackling a challenge. Most would probably think the best way to solve a problem would be to focus on it â€" to think analytically â€" and then to keep reworking the problem. In fact, the opposite approach is better, DeHaan argues. Herschbach, for example, made an important discovery in chemistry shortly after he learned of a technique in physics called molecular beams. This technique allows researchers to study the motion of molecules in a vacuum, an environment free of the gas molecules that make up air. He reasoned that by crossing two beams of different molecules, he might learn more about how quickly reactions occur as molecules collide with one another. It was called the lunatic fringe of chemistry, which I just loved. He spent several years collecting his data, which in the end uncovered new insights into the ways colliding molecules behave. So you come to the field fresh, without any expectations, sometimes called preconceptions. You just need to broaden your thinking in ways that allow your mind to connect ideas that you might not have thought were related. In this approach, a teacher presents a problem or question with no clear or obvious solution. Students are then asked to think broadly about how to solve it. Problem-based learning can help students think like scientists, Wallace says. He cites an example from his own classroom. Last fall, he had students read about fruit flies that lack an enzyme â€" a molecule that speeds up chemical reactions â€" to break down alcohol. He asked his students to find out whether these flies would feel the effects of alcohol, or even become inebriated, sooner than would flies that possess the enzyme. In fact, she and many educators agree, when something comes out differently than expected, it provides a learning experience. Working on a team, he says, introduces a concept called distributed reasoning. Sometimes called brainstorming, this type of reasoning is spread out and conducted by a group of people. Smith cautions against confusing artistic or visual representations of science with scientific creativity. In the end, educators and scientists agree that anyone can learn how to think like a scientist. But he insists just the opposite is true.

Chapter 6 : How creativity powers science | Science News for Students

But creative thinking, DeHaan and others say, isn't always the focus of teaching in science classrooms. "A lot of kids think that science is a body of knowledge, a collection of facts they need to memorize," says Bill Wallace, a science teacher at Georgetown Day School in Washington, D.C.

Great art and great science have a link, a link that begins deep within curious minds, a link that involves combining thoughts, stirring memories, perceiving sensations, creating new ideas, and producing original products. At the middle of the last century, linking creativity and science seemed odd, not especially practical - even comical. Science was considered a rational study of observable facts and phenomena, and creativity seemed more mystical and transcendent. Yet after psychologists started investigating creativity, and research started to gain traction, the concept of creative patterns of thought across all disciplines â€" not just artistic expression â€" began to seem plausible. The idea that certain creative thought patterns lend themselves to certain disciplines began to intrigue and perplex researchers. More intriguing was the idea that creative thought patterns influenced rational and logical thought processes. A great part of that intrigue started after researchers began looking at the career and success of many important 20th scientists, scientists who discovered the theory of relativity, quantum theory, superconductivity, nuclear power, gene mapping, radioactivity, nuclear power, genetic engineering â€" to name only a few. These scientific discoveries and inventions took the world as we knew it, and transformed it into the most scientifically and technically advanced era in history. Einstein Breaks Scientific Stereotype Clearly, one of the most celebrated scientists of the last century was Albert Einstein, credited for founding the era of modern physics, and discovering the theory of relativity. In he won the Nobel Prize, resulting in continuous attention from journalists, other scientists, and the public until the end of his life in Individuals also listen to symphonies and feel moved, or receive satisfaction from paintings, dance, or sculpture. In other words, many individuals would enjoy an article in The New Yorker, and not get anything out of an article in the Journal of Experimental and Theoretical Physics. A further test for a truly significant scientific breakthrough is how many times a published scientific journal article gets cited in subsequent articles. One thing that made Einstein so irresistible â€" and irrepressible - was the fact that he personified the opposite of the scientific stereotype. As a youth, he showed no remarkable gifts or abilities, and some have even reported early struggles with talking and reading. In recent publications, others have disputed those claims. He never wore ties or pressed shirts or white lab coats. He played the violin, and he loved long solitary days to just sit and think. He wore sweatshirts and shabby sweaters, his long unruly hair and mustache, gray and wiry in his later years, always looked as if it needed combing. He was a romantic and a flirt, divorced his first wife and angered his second with his romantic dalliances. And his interviews and writings supported his unorthodox persona. In a interview, a journalist questioned him about whether his scientific discoveries resulted from inspiration or intuition. His answer was that he used both. However, he then added: Imagination encircles the world. Up until the s, most researchers believed that intelligence and creativity were highly correlated. During the s and s, however, psychologists started to debunk the high- intelligence, high-creativity link. Tests emerged that showed individuals could score high on creativity and average on IQ, and proceed to lead highly creative and successful careers. But after establishing that creative thought does differ from other types of thought, researchers started investigating different forms of creativity, such as creativity in science as compared to creativity in the arts. Even though creativity is required in both domains, the fact remains that science is significantly different from art. Domain-Specific Creativity or discipline, requiring a completely separate set of skills and talents. Creativity researchers now take numerous approaches to studying creativity in science, usually focusing on either the process, the personal attributes of eminent scientists, the creative product or outcome produced â€" or a combination of all factors. Cognitive Complexity But many experts who study scientific thought as well as creativity in science believe in another essential aspect to this complex topic.

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Many books, papers, and essays have documented the unique ability of creative scientists to assimilate knowledge from many different disciplines in order to produce highly original products. Laws are considered facts of the universe, unless disproved by new discoveries of facts or evidence overturning the facts. Technology bases its inventions on the Fundamental Laws of Science. Sometimes inventions precede the discovery of these Laws, however. For instance, the Steam Machine was invented before the discovery of Thermodynamics; however after the discovery of Thermodynamics, scientists fully understood this invention, Zichichi states. Creativity is required in both science discovery and technological invention. They tend to bring ideas from one field of knowledge into another field. His analysis attempted to understand what set these eminent scientists apart from other scientists. Also, chemist Gertrude Elion received the Nobel Prize in Physiology or Medicine in , and John Bardeen received the Nobel Prize twice, first in for the invention of the transistor, then in for the theory of superconductivity. What set these scientists apart from others who seemingly have a high degree of passion for their scientific fields? Neuroscience and Literary Fiction Ashok N. Hegde, PhD, is a neuroscientist and a creative writer. Her friends attended strict French schools, but Curie received a private education. Hollingsworth states that her ability to socialize and live in these disparate worlds contributed to her high cognitive ability. Gertrude Elion also had to internalize her Jewish background while growing up in America as the daughter of immigrants. Additionally, she entered a male-dominated profession â€" another culture to assimilate. Hence, the requirement to function within multiple cultures developed her skill for high cognitive complexity. Hollingsworth noted that those who developed avid avocations, especially in the arts, also displayed highly complex cognitions similar to the more culturally diverse scientists. Hollingsworth lists numerous scientists with hobbies in the visual arts, writing, music, drama, architecture and woodworking. These scientists reported that their avocations aided their scientific accomplishments. They are more tolerant of ambiguity; They are more comfortable not only with new findings but even with contradictory findings; They have a greater ability to observe the world in terms of gray rather than in terms of black and white; They report that learning new things and moving into new areas is like play; They tend to be more intuitive; They have a high degree of spontaneity in their thinking; They enjoy exploring uncertainty and engaging in high- risk research rather than working in areas which are already well understood. Science presents a different challenge than studying the arts, for instance, but is as important as any other domain. Research in this area is often applied to educational fields, as well as to business and technology-based industries. If you are interested in studying creativity in science from a psychological perspective, there are many fields available for study, including Human Growth and Development , Cognitive Psychology , Social Psychology , Educational Psychology , and Media Psychology. To become a researcher in psychology, usually a PhD is required. However, some schools offer certificates in creativity studies. Contact schools that offer psychology programs for more information. The Chinese Creativity Crisis When Americans discuss their educational system, and what they perceive is lacking, they often point to the Chinese and the media coverage of their preeminence in math and the sciences. But the debate over education is strongly supported by international studies, and the test scores of Chinese students. Chinese students came out first in math, science and reading while U. Blogs, pundits, and those crying for educational reform in this country hit the media hard with their commentaries on the failing quality of the current system. Americans are getting beat â€" badly â€" at least in terms of standardized test scores, and that sets off alarms among policymakers, the U. For several years, those in China have been calling for educational reform. They cite a system lacking in something that keeps America at the forefront of innovation and ingenuity â€" an ingredient essential to novelty, invention, and economic development. Many call that magic ingredient creativity. New York Times reporter Nicolas D. The solution for both systems seems incomprehensible. Developing nations take note.

Chapter 7 : Hot streak: Finding patterns in creative career breakthroughs | Penn State University

Hot streak: Finding patterns in creative career breakthroughs International research team discovers career hot streaks occur in science, art and film.

The schools served as communities which advised the rulers of these states. Needham further notes that the Han Dynasty , which conquered the short-lived Qin, were made aware of the need for law by Lu Chia and by Shu-Sun Thung , as defined by the scholars, rather than the generals. The practice of acupuncture can be traced back as far as the 1st millennium BC and some scientists believe that there is evidence that practices similar to acupuncture were used in Eurasia during the early Bronze Age. It listed 29 comets referred to as sweeping stars that appeared over a period of about years, with renderings of comets describing an event its appearance corresponded to. Typical Chinese architecture changed little from the succeeding Han Dynasty until the 19th century. Several remains of crossbows have been found among the soldiers of the Terracotta Army in the tomb of Qin Shi Huang. Science and technology of the Han Dynasty The Eastern Han Dynasty scholar and astronomer Zhang Heng 78â€" AD invented the first water-powered rotating armillary sphere the first armillary sphere having been invented by the Greek Eratosthenes , and catalogued 2, stars and over constellations. In , he invented the first seismological detector , called the "Houfeng Didong Yi" "Instrument for inquiring into the wind and the shaking of the earth". Ma Jun improved the design of the silk loom , [15] designed mechanical chain pumps to irrigate palatial gardens, [15] and created a large and intricate mechanical puppet theatre for Emperor Ming of Wei , which was operated by a large hidden waterwheel. It incorporated the use of a differential gear in order to apply equal amount of torque to wheels rotating at different speeds, a device that is found in all modern automobiles. Paper and printing were developed first. Printing was recorded in China in the Tang Dynasty , although the earliest surviving examples of printed cloth patterns date to before Gunpowder, for example, spread to the Arabs in the 13th century and thence to Europe. Printing, gunpowder and the compass: These three have changed the whole face and state of things throughout the world; the first in literature , the second in warfare , the third in navigation ; whence have followed innumerable changes, in so much that no empire, no sect, no star seems to have exerted greater power and influence in human affairs than these mechanical discoveries. For the 11th century invention of ceramic movable type printing by Bi Sheng , it was enhanced by the wooden movable type of Wang Zhen in and the bronze metal movable type of Hua Sui in Chinese junks are described as very large, three or four-masted ships. Among the engineering accomplishments of early China were matches , dry docks , the double-action piston pump , cast iron , the iron plough , the horse collar , the multi-tube seed drill , the wheelbarrow , the suspension bridge , the parachute , natural gas as fuel, the raised-relief map , the propeller , the sluice gate, and the pound lock. Technology of the Song Dynasty The Song Dynasty â€" brought a new stability for China after a century of civil war, and started a new area of modernisation by encouraging examinations and meritocracy. The first Song Emperor created political institutions that allowed a great deal of freedom of discourse and thought, which facilitated the growth of scientific advance , economic reforms, and achievements in arts and literature. In it, he wrote of use for a drydock to repair boats, the navigational magnetic compass , and the discovery of the concept of true north with magnetic declination towards the North Pole. Shen Kuo also devised a geological theory for land formation, or geomorphology , and theorized that there was climate change in geological regions over an enormous span of time. The clock tower was driven by a rotating waterwheel and escapement mechanism. Crowning the top of the clock tower was the large bronze, mechanically-driven, rotating armillary sphere. This pharmaceutical treatise covered a wide range of other related subjects, including botany , zoology , mineralogy , and metallurgy. Chinese astronomers were the first to record observations of a supernova , the first being the SN , recorded during the Han Dynasty. Chinese astronomers made two more notable supernova observations during the Song Dynasty: Ebrey says pioneered ideas in early epigraphy and archaeology. Shen believed that land was reshaped over time due to perpetual erosion , uplift, and deposition of silt , and cited his observance

of horizontal strata of fossils embedded in a cliffside at Taihang as evidence that the area was once the location of an ancient seashore that had shifted hundreds of miles east over an enormous span of time. Chinese corps, expert in siege warfare, formed an integral part of the Mongol armies campaigning in the West. In military alliance of the Franks knights of the ruler of Antioch , Bohemond VI and his father-in-law Hetoum I with the Mongols under Hulagu , in which they fought together for the conquests of Muslim Syria , taking together the city of Aleppo , and later Damascus. Muslim astronomers worked in the Chinese Astronomical Bureau established by Kublai Khan, while some Chinese astronomers also worked at the Persian Maragha observatory. Huff notes, pre-modern Chinese science developed precariously without solid scientific theory , while there was a lacking of consistent systemic treatment in comparison to contemporaneous European works such as the Concordance and Discordant Canons by Gratian of Bologna fl. The men of old changed the name of their methods from problem to problem, so that as no specific explanation was given, there is no way of telling their theoretical origin or basis. Yang Hui provided theoretical proof for the proposition that the complements of the parallelograms which are about the diameter of any given parallelogram are equal to one another. Traditional Chinese medicine There were noted advances in traditional Chinese medicine during the Middle Ages. Emperor Gaozong reigned â€” of the Tang Dynasty â€” commissioned the scholarly compilation of a materia medica in that documented medicinal substances taken from stones, minerals, metals, plants, herbs, animals, vegetables, fruits, and cereal crops. Horology and clockworks Although the Bencao Tujing was an important pharmaceutical work of the age, Su Song is perhaps better known for his work in horology. During the 11th century, the growth of the iron industry caused vast deforestation due to the use of charcoal in the smelting process. Chinese mathematics Qin Jiushao c. Excavated bombs contain a cm opening at the top where the fuse was placed. Once the fuse was lit, the bomb was thrown either by hand or catapult. Chinese alchemy In their pursuit for an elixir of life and desire to create gold from various mixtures of materials, Taoists became heavily associated with alchemy. A 10th-century silken banner from Dunhuang portrays the first artistic depiction of a fire lance , a prototype of the gun. The Jesuit China missions of the 16th and 17th centuries introduced Western science and astronomy, then undergoing its own revolution, to China. One modern historian writes that in late Ming courts, the Jesuits were "regarded as impressive especially for their knowledge of astronomy, calendar-making, mathematics, hydraulics, and geography. They made very extensive astronomical observation and carried out the first modern cartographic work in China. They also learned to appreciate the scientific achievements of this ancient culture and made them known in Europe. Through their correspondence European scientists first learned about the Chinese science and culture. Matteo Ricci started to report on the thoughts of Confucius, and Father Prospero Intorcetta published the life and works of Confucius into Latin in Great Divergence One question that has been the subject of debate among historians has been why China did not develop a scientific revolution and why Chinese technology fell behind that of Europe. Many hypotheses have been proposed ranging from the cultural to the political and economic. Fairbank , for example, argued that the Chinese political system was hostile to scientific progress. As for Needham, he wrote that cultural factors prevented traditional Chinese achievements from developing into what could be called "science. It was not that there was no order in nature for the Chinese, but rather that it was not an order ordained by a rational personal being, and hence there was no conviction that rational personal beings would be able to spell out in their lesser earthly languages the divine code of laws which he had decreed aforetime. Sivin suggests that we need to look at the scientific development in China on its own terms. Because its theory predates use of the scientific method , it has received various criticisms based on scientific thinking. Philosopher Robert Todd Carroll , a member of the Skeptics Society, deemed acupuncture a pseudoscience because it "confuse s metaphysical claims with empirical claims".: It argues that the Chinese population was large enough, workers cheap enough, and agrarian productivity high enough to not require mechanization:

Chapter 8 : History of science and technology in China - Wikipedia

collections. Recommender. The apps, books, movies, music, TV shows, and art are inspiring our some of the most creative people in business this month.

I tailored them to his interests and you can do the same for your kids. This list is up dated frequently as we add in new experiments! Or you can try the classic walking water science activity. We have 10 unique baking soda science activities to try it out! Well we have tons more but these will get you started! Or try an erupting rainbow. Set up a simple balloon rocket. All you need is string, a straw, and a balloon! This science activity will have you on the edge of your seat! Also a great way to use up leftover candy! Can you make a bubble bounce? We have any easy recipe for the perfect bubble solution. Check out even more bubble fun with a bubble STEM challenge for young kids! Check out our fun frozen color mixing science activity! You can easily grow your own crystals at home or in the classroom with this simple recipe. Make a rainbow , a snowflake , hearts , crystal eggshells , and even crystal seashells. Learn how to grow salt crystals! Find out with this liquid density experiment! Explore all kinds of simple science ideas right in a bottle! Check out a few of our easy science bottles or these discovery bottles for ideas. They are perfect for themes too like these Earth Day ones! Plus it is a great frugal activity. Check out a variety of structure building activities. Try a color changing flower science experiment and learn about how a flower works! Have young kids explore concepts in gravity around the house or classroom. Make tasty science with edible rock geodes and learn a little bit about how they form! Ice melting is a wonderful introduction to a simple science concept for young kids! One bar of ivory soap can be very exciting! See how we experimented with one bar of soap and turned it into either soap foam or soap slime! This was fascinating and pretty quick. We watched the new lettuce grow taller each day! You can set up a magnet science discovery table for your kids to explore as well as a magnet sensory bin! A simple recipe using kitchen cupboard ingredients, but it is the perfect example of a non-newtonian fluid. Also makes for fun sensory play. Make classic oobleck or colored oobleck. Even flat pieces of wood or stiff cardboard work! Check out a great ramps and friction post I wrote for Pre-K pages! It is an excellent way to see how a seed grows! Young kids are learning to use their senses every day. Set up a simple 5 Senses Science Table for exploring and learning how their senses work! Our candy taste test and senses activity is fun too. SLIME Slime is our top activity here, and our simple homemade slime recipe is perfect for learning a little bit about polymers. Or just use it as a fun play recipe! We have dozens of themed slime ideas for the entire year! Build a sandbox volcano or a LEGO volcano! Make sure to save our apple-cano and pumpkin-cano for Fall science. Explore science concepts through play. The world around us in an awesome place to explore for the young scientist. Create a natural love for learning and exploring with these simple but important preschool science concepts. A love of learning begins now! Amazon Affiliate links for our favorite science tools.

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Chapter 9 : Sudden Genius: The Gradual Path to Creative Breakthroughs | Oxford University Press

Sunday newsletter. Brain Pickings has a free Sunday digest of the week's most interesting and inspiring articles across art, science, philosophy, creativity, children's books, and other strands of our search for truth, beauty, and meaning.

About the author The highly admired scientist Linus Pauling, a double Nobel laureate in chemistry and peace, was once asked by a student. Why do some people have many more of them than others? How do you distinguish the good ideas from the bad? These questions are the subject of this book. Andrew Robinson explores the exceptional creativity in both scientists and artists by following the trail that led ten individuals from childhood to the achievement of a famous creative breakthrough as an adult, in archaeology, architecture, art, biology, chemistry, cinema, music, literature, photography, and physics. Broken into three parts, the book begins with the scientific study of creativity, covering talent, genius, intelligence, memory, dreams, the unconscious, savant syndrome, synaesthesia, and mental illness. Intelligence is not enough 3. Strange to ourselves 5. Leonardo da Vinci - The Last Supper 7. The Marriage of Figaro 9. Decipherment of Egyptian hieroglyphs Evolution by natural selection Discovery of radium The Decisive Moment Professor of the little finger Creative science versus artistic creation Is there a creative personality? Reputation, fame, and genius Andrew Robinson is the author of some twenty books covering both the arts and the sciences, which have been acclaimed by both national newspapers and specialist journals. They include five biographies of exceptionally creative individuals in a wide range of fields: For many years he worked in book publishing, television, and journalism, most recently as Literary Editor of The Times Higher Education Supplement from Recommendations from the same category.