**Listening**

**Watch the video three times and take down some notes on rough paper. Finally, answer the following questions.**

1. **True or false? Circle the right answer and do not justify.**
   1. Leonardo of Pisa lived in the thirteenth century. TRUE / FALSE

“He introduce the rabbit problem about 800 years ago.”

* 1. If you add three numbers of the Fibonacci sequence, you get the next number. TRUE / FALSE

This is actually when you add the two last numbers

* 1. The fact that some Fibonacci numbers can be found in nature has a mathematical explanation. TRUE / FALSE

For example, when a flour grows, it’s beneficial for it to push out each new petal as far as possible from the existing one.

* 1. If you divide two consecutive numbers of the Fibonacci sequence, you get the number pi. TRUE / FALSE

In fact, you get the golden angle.

1. **Fill in the blanks with the missing words.** 
   1. *(0’52 => 1’01)* “It typically contains two types of spirals. (…) 34 and 55 appear back to back in the Fibonacci sequence.”
   2. *(2’10 => 2’17)* “ (…), isn’t it even lovely you knowing that there is a deep mathematical order to it? For Scientific American’s *Instant* egghead, I’m John Matson”
2. **Answer the following questions using your own words and full sentences.**
3. Explain the link between the Fibonacci sequence and rabbits.

The rabbits reproduction is working a like the Fibonacci sequence. They aren’t so predictable but the number of each generation can be see, to simplify, as the sum of the last.

1. Explain the link between the Fibonacci sequence and certain vegetables.

The organisation of some vegetables structure following the Fibonacci sequence. The number of each circle thorns of a pine cone is the sum of the two last, for example.

**Reading**

**Read the text carefully. Highlight key sentences. Then, choose a title that conveys the main idea of the article.**

**…………………………………………………………..**

**By**[**Robert Root-Bernstein**](mailto:rootbern@msu.edu)**2 July, 2018**

[**https://blogs.sciencemag.org/books/2018/07/02/science-and-the-arts-essay/**](https://blogs.sciencemag.org/books/2018/07/02/science-and-the-arts-essay/)

If you’ve ever had a medical procedure, chances are you benefited from the arts. The stethoscope was invented by a French flautist/physician named René Laennec who recorded his first observations of heart sounds in musical notation. The suturing techniques used for organ transplants were adapted from **lacemaking** by another Frenchman, Nobel laureate Alexis Carrel. The methods (and some of the tools) required to perform the first open-heart surgeries were invented by an African-American innovator named Vivien Thomas, whose formal training was as a master carpenter.

But perhaps you’re more of a technology lover. The idea of instantaneous electronic communication was the invention of one of America’s most famous artists, Samuel Morse, who built his first telegraph on a canvas stretcher. Actress Hedy Lamarr collaborated with the avant-garde composer George Antheil to invent modern encryption of electronic messages. Even the electronic chips that run our phones and computers are fabricated using artistic inventions: **etching**, silk-screen printing, and photolithography.

On 7 May 2018, the Board on Higher Education and Workforce of the U.S. National Academies of Sciences, Engineering, and Medicine (NASEM) released a report recommending that humanities, arts, crafts, and design (HACD) practices be integrated with science, technology, engineering, mathematics, and medicine (**STEMM**) in college and post-graduate curricula. The motivation for the study is the growing divide in American educational systems between traditional liberal arts curricula and job-related specialization. “Ironically,” the report notes, “as this movement toward narrower, disciplinary education has progressed inexorably, many employers—even, and, in fact, especially in ‘high tech’ areas—have emphasized that learning **outcomes** associated with integrated education, such as critical thinking, communication, teamwork, and abilities for lifelong learning, are more, not less, desirable.”

Because the ecology of education is so complex, the report concludes that there is no one, or best, way to integrate arts and humanities with STEMM learning, nor any single type of pedagogical experiment or set of data that proves incontrovertibly that integration is the definitive answer to improved job preparedness. Nonetheless, a preponderance of evidence converges on the conclusion that incorporating HACD into STEMM pedagogies can improve STEMM performance.

Large-scale statistical studies have demonstrated significant correlations between the persistent practice of HACD with various measures of STEMM achievement. Niemi reports, for example, that individuals who practice the arts are more likely **to file patents**. My colleagues and I, meanwhile, have found that STEMM professionals with avocations such as wood- and metalworking, printmaking, painting, and music composition are more likely to file and license patents and to found companies than those who lack such experience. Likewise, authors that publish high-impact papers are more likely to paint, sculpt, act, engage in wood- or metalworking, or pursue creative writing. Members of the U.S. National Academies of Sciences and Engineering are about three to five times more likely to have a lifelong **avocation** involving arts, crafts, theater, or some type of creative writing than are average scientists, and Nobel Prize winners engage in such activities at 15 to 25 times the rate of average scientists.

Every scientist knows that correlation is not causation, but many STEMM professionals report that they actively integrate their HACD and STEMM practices. In 2013, my colleagues and I conducted a survey of 225 scientists and engineers and found that more than 60% could cite a direct impact of their HACD activities on their STEMM work, and over 80% recommended that HACD be a required part of STEMM education.

“I spent vast hours in a woodworking shop [my father] maintained in the **basement** of our house, building gadgets,” wrote Richard Smalley, winner of the 1996 Nobel Prize in Chemistry, in his Nobel autobiography. “My mother taught me mechanical drawing so that I could be more systematic in my design work, and I continued in drafting classes throughout my 4 years in high school. This … was a wonderful preparation for my later career as an experimentalist working on the frontiers of chemistry and physics.”

Nobel laureate Dorothy Crowfoot Hodgkin attributed her success in crystallography, in part, to learning symmetry operations as a teenager while illustrating floor tilings for her parent’s archaeological papers. “I began to think of the restraints imposed by two-dimensional order in a plane,” she reveals in Georgina Ferry’s 1998 biography.

Artistic innovations can even **drive** sciences and technologies. In 1990, for example, the National Endowment for the Arts funded a collaboration between conceptual artist Mel Chin and botanist Rufus Chaney to create an environmental art experiment called Revival Field. The piece provided the first proof of concept that plants can take harmful compounds such as lead, arsenic, and cobalt out of contaminated soil. Chin and Chaney’s collaboration opened up a phytoremediation market currently estimated to be worth $36 billion to $54 billion in the United States and Europe. Not a bad return on an investment of $70,000.

Analyses of hundreds of individual case studies reveal that STEMM professionals often link HACD with STEMM practices by means of 13 mental “tools for thinking”: observing (using any or all senses); imaging; abstracting; pattern recognition; pattern forming; dimensional thinking; analogizing; proprioceptive (or body) thinking; empathizing or play-acting (Nobel laureate Barbara McClintock reported having “a feeling for the organism” and Jonas Salk of “becoming the virus”); modeling; playing; transforming between these various ways of thinking; and synthesizing.

Such tools have also proven to be useful for successfully integrating HACD-STEMM pedagogies in K-12, college, and postgraduate classrooms. Drawing, for example, develops observational and visual thinking skills that facilitate STEMM learning. Tailored musical or artistic pedagogical interventions improve visual and aural observational skills among STEMM students. And developing transformational and synthetic thinking skills by inventing and producing one’s own scientific game or model has greater pedagogical effectiveness for STEMM students than passively playing with one.

HACD and STEMM disciplines are valuable to each other only to the extent to which they are understood to contribute complementary principles, methods, ideas, and content that have emerged from their characteristic approaches. One set of disciplines cannot become the **handmaid** of the other without losing their mutual benefits.

Integration occurs best through the building of conceptual or methodological “bridges” between disciplines for the purpose of addressing well-defined multi- or transdisciplinary problems. Integration is not a goal in and of itself, but rather a skill that needs to be developed in order to respond to the connectedness of the real world.

The NASEM report on STEMM-HACD integration repeatedly emphasizes that every real-world problem spans disciplinary boundaries. To quote the embryologist, dancer, and artist Conrad Hal Waddington, “The acute problems of the world can be solved only by whole men, not by people who refuse to be, publicly, anything more than a technologist, or a pure scientist, or an artist”. The late Charles M. Vest, president emeritus of the National Academy of Engineering and president emeritus of the Massachusetts Institute of Technology, concurred: “[Engineering] systems cannot be wisely envisioned, designed, or deployed without an understanding of society, culture, politics, economics, and communications—in other words, the very stuff of the liberal arts and also of the social sciences.”

**1. Read the text again and decide whether the following statements are True or False (give brief evidence from the text):**

|  |  |
| --- | --- |
| 1.Wood-working techniques were key to the performance of the first open-heart surgeries.  “the first open-heart surgeries were invented by an African-American innovator named Vivien Thomas, whose formal training was as a master carpenter.” | **True**  **False** |
| 2.Phones and computers were first invented by famous artists.  “The idea of instantaneous electronic communication was the invention of one of America’s most famous artists, Samuel Morse, who built his first telegraph on a canvas stretcher.” | **True**  **False** |
| 3.University degrees in America are increasingly separating science learning from arts and humanities learning.  “(NASEM) released a report recommending that [...] (HACD) practices be integrated with [...] (STEMM) in college and post-graduate curricula.” | **True**  **False** |
| 4.The business world is doing the same.  “Ironically,” the report notes, “as this movement toward narrower, disciplinary education has progressed inexorably, many employers—even, and, in fact, especially in ‘high tech’ areas—have emphasized that learning outcomes associated with integrated education, such as critical thinking, communication, teamwork, and abilities for lifelong learning, are more, not less, desirable.” | **True**  **False** |
| 5.There is wide evidence that arts and humanities can improve STEMM achievement.  “My colleagues and I, meanwhile, have found that STEMM professionals with avocations such as wood- and metalworking, printmaking, painting, and music composition are more likely to file and license patents and to found companies than those who lack such experience.” | **True**  **False** |

1. **Read the text and answer the following questions briefly (quote lines from the text):**
2. Why did the NASEM decide to make a report on STEMM and HACD learning?

Because there is a fracture between American educational systems and arts.  
“The motivation for the study is the growing divide in American educational systems between traditional liberal arts curricula and job-related specialization. “

1. What were the main findings of the report?

That it could be beneficial to mix the education of NASEM and HACD to generate greater creativity in these two disciplines.

1. Can you quote two examples from the text that demonstrate the correlation between HACD practice and STEMM achievements?

“The stethoscope was invented by a French flautist/physician named René Laennec who recorded his first observations of heart sounds in musical notation.”

“The methods (and some of the tools) required to perform the first open-heart surgeries were invented by an African-American innovator named Vivien Thomas, whose formal training was as a master carpenter.”

1. Which is the best way to integrate HACD-STEMM pedagogies in graduate and postgraduate education, according to the report?

The report concludes that there is no one, or best, way to integrate arts and humanities with STEMM learning.

1. **Find synonyms for the words in bold.**

**Write the following numbers in letters:**

* 32 - thirty two
* 89 - eighty-nine
* 425 - four hundred and twenty five
* 873 - eight hundred and seventy three
* 342,713 - three hundred and forty two thousand seven hundred and thirteen
* 569,045 - five hundred and sixty nine thousand and forty five
* 2,450,000 – two million four hundred and fifty thousand
* 27,805,234 - twenty seven million eight hundred and five thousand two hundred and thirty four
* 2.36 - two point thirty six
* 14.82 - fourteen point eighty two
* *87% - eighty seven percent*
* 3/8 - three eighth
* 5/16 - five sixteenth
* 7/8 – seventh eighth
* 1/4- a quarter
* 2/3 - two-thirds
* 1/2 – a half
* 100 mph – a hundred miles per hour
* 212-555-1212 - two hundred twelve – five hundred fifty five – one thousand two hundred and twelve
* $175.50 - one hundred seventy five point fifty dollars