The educational model of STEAM in modern education.
From the Experience of Construction to the Theory of Science
“Mathematics in Technology”

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The way we understand things and not just perceive them, is neither simple nor obvious. The complex functions of the brain, transform the data of the outside world into information, which in turn, forms our conceptual world and ultimately shapes our consciousness.

It is our hands and our eyes that create the "tool" and form the "image". Through the tools and images man was led to Science and Art.

In the history of the evolution of the human species, the transition from experience to theory, has taken many millions of years to bear the fruits of the knowledge we have today. We are now called upon to shrink this long period of biological evolution and turn it into an educational model for the education of children.

Technological constructions were made long before their scientific interpretation [which explained (why?) they were designed the way they were but also (why?) they worked the way they appeared to work]. This means that humans first made machines and then turned the experience of his constructions into a challenge (purely conceptually) that through generalizations he assembled into theories. In other words, he created Science.

The revolutions that change people's lifestyles and create new cultures are directly linked to technological breakthroughs. The invention of machines was the result of man's need to extend his physical powers. The invention of computers and digital technology is the fulfillment of the need to extend the powers of his mind.

Human societies create Civilizations. At the heart of every culture is its education. Education is built on the basis of a Strategy. This strategy is called Education. The Tools of Education are the various Educational Models that follow the evolution of society and have to be supplemented, rearranged or even completely changed. STEAM is a suggestion of such an Educational Model.

But beyond any theoretical placements, a historical journey from the Paleolithic to the present day could show that STEAM is not just a model of education, but it is the reality itself that shows us how we came together and also how we continue to build on our own life experiences and make them knowledge.

About 2,000,000 years ago, the distant human ancestor appeared somewhere in East Africa. This man's needs were: safety from large carnivorous animals, protection from environmental conditions and meeting his biological needs, such as food and water. His food was obtained through fruit harvesting and animal hunting. But the animals that would provide him with food were faster and many times stronger than him. Therefore, he had to extend his physical strength to cope with these conditions. This is achieved by the invention of the first tools. Stones, wood and plant fiber are the materials needed to make axes, bows and arrows.

After about a million years, he discovers a new tool that will help him solve a big problem. The caves, which are protected by the weather, were inhabited by wild beasts who were not very willing to leave them. He observes, however, that the friction of dry sticks between them produces fire. The fire scares wild beasts, while at the same time providing heat when it is cold. Fire is the new tool added to his collection of tools and it is one that will change significantly from here on after his life.

Around 400,000 BC, he observes that the food resources available around the caves are running out and he will have to move away from them to find his food. The safety of the cave is followed by the fear of the distant unknown. This fear is best handled when they are with others, rather than alone. Thus, the collective consciousness develops. The fear that is directly linked to death must be exorcised and spells want rituals. Rituals need representations to show what they are warding off. Then he discovers two new tools: hard stones that can scratch cave surfaces and paint. With

the new tools he creates images and uses them to destroy the evil that can cause death. They will help him overcome the fear of death. They will make him stronger.

Around 33000 BC, one realizes that not only do the caves not fit many people, so large groups cannot be developed, but also that the caves are not always in ideal locations. This means that he had to build his own cave. Using materials found in its surroundings, such as wood, plant fiber, grass, stones, water and dirt, he builds the first structured architectural constructions. He builds the first houses and at the same time the first settlements.

Around 10000 BC, larger groups of people are being created and the resources available in the surrounding area are insufficient to feed the entire population. He observes, however, that the earth periodically germinates and that this was something that could help him secure his food supply. But she needed a tool to shape its soil, then plant seeds in it and finally collect the fruit. Using hardwoods and ropes he built the plow, tamed the big animals and built the first machine that would change his story forever. The man from hunter became a farmer.

Around 5000 BC, there is now production of cereals and other crops. However, harvesting occurred at a specific time of year. They should therefore be stored in order to provide food for the whole year. This creates the need to store products. With the tools of clay and fire man makes large and small containers, in which he places the products of his production. Because the new constructions were closed, he had to know what they contained, without ever opening them. Using the colors, he painted the symbols on the containers with which he recognized what was in each container. The introduction of symbols becomes the first intellectual storage activity. An imaginary symbol corresponds to a quality material. If the plow was a revolution in technology, the symbols were a revolution in mental abstraction and communication.

Around 4500 BC, the existence of resources raises new concerns for man, since he now has to somehow distribute those resources to group members. The products should be extracted from the storage containers in such a way that the containers are not damaged. Using clay again, fire and paint he makes smaller containers that draw quantities of products through the storage containers. These small containers will form the basis on which the idea of the unit of measure will be developed.

In about 4000 BC, man specialized in the arts he conquered. He observes and learns. He gains greater depth in what he deals with and that brings more progress and specialization in fields. All these contribute to the formation of the first structured societies. The existence of these societies implies the existence of rules (laws). Their rules are laid by one who is prudent and has greater authority. Prudence is about logic. But power has mainly to do with weapons. Arms manufacturing is therefore favored during this period. Old weapons are improved and new ones are manufactured.

Around 3800 BC, the increase in production creates a surplus of resources in developed societies, both in raw materials and in processed ones. Surplus storage requires the erection of buildings and in many cases suitable for the preservation of products. The architecture of these buildings requires proper materials and proper design. In parallel with the storage of products, the sector of product transportation from place to place is developing. This requires means of transport, appropriate product containers to be manufactured and new product identification symbols embedded in the containers. This is the time when relationships between people will require the existence of a common code of communication.

The year 2000 BC is characterized as the Bronze Age. Communication with people is becoming more demanding. Individual symbols are not enough to meet the demands of a more complex society. Thus, not only are new ones created, but a kind of syntax is also developed, which helps to more accurately register and classify products. Tables are drawn and printed on clay plates. The records relate to the economy, administration and religious ceremonies. These plates are the first official external databases, which clearly show that the capacity of human memory is limited.

In 900 BC, through the Homeric epics of the Iliad and the Odyssey, we are informed, not only of important construction records, but also of important records of automatons. Achilles' shield, Trojan Horse, automatic tripods, Faeak ships and the Talos robot are just some of these constructions. The relationship between gods and humans exists mainly through the power and imagination of the constructions. People's creativity and their curiosity to get to know the natural world forces them to create new and more complex constructions.

In 600 BC, designated as the beginning of the classical age of antiquity, Empirical Technology is replaced by Science. Man seeks to find the relation between cause and

effect to create firm rules. Through the generalization of observations, he creates universal models. Philosophy overshadows technology at this time, and it seems that the intellectual world of classical antiquity has little to do with technological constructions. However, this is not true. High-quality technological tools are created and sophisticated machines are manufactured to meet the architectural needs of buildings such as the Parthenon or the naval and general military needs of a superpower such as Athens. Levels, pulleys, lifting machines, scaffolding, hydraulic clocks, hydraulic door swing systems, are some of the many technological achievements of this period. However, they are technological breakthroughs that not only have the empirical character of previous constructions, but are manufactured after being first studied and calculated according to the mathematical knowledge of the time and designed according to geometric methods on paper.

In the 1st century BC a Roman engineer named Vitruvius writes a very important work, *DE ARCHITECTURA*, which will play a particularly important educational role in the West until our century, while at the same time giving us valuable information on many branches of Greek technology. He writes in the introduction of his work that the architect is armed with knowledge of many sciences and experience of various arts, because in this way he can judge everything that man makes. Architecture is the fruit of Practice and Theory. Vitruvius uses the term architecture in a broader sense than we use it today, stressing at the end of his work that the result of a construction is not so much achieved by machines as by the skill of the engineer. In this way Vitruvius adds a humanistic approach to the construction work, which will be the foundation of the Renaissance.

In the 15th century the foundations of science are laid as we mean it today. The discovery of the telescope in the 17th century will lead Galileo to confirm his astronomical observations about the phases of the moon and to confirm our planetary system as a solar center. . Observation technology is booming. Science will only come to theoretical conclusions after repeated observations and experiments. Kepler's astronomical observations and the empirical laws he came up with for the rotation of planets around the sun will gain universal validity through Newton's theoretical work, which will prove them using Mathematics. In the 18th century, it is realized that the power that can be produced by heat can be made suitable for production if man can make machines that are driven by it. The study of these machines is of the utmost

interest, their importance is enormous, and their use is constantly increasing, thereby pointing to a major revolution in the civilized world. The construction of steam engines and factories create a new society that will be characterized as Industrial. People's lives will henceforth be inextricably linked to the evolution of the machines than man himself envisioned and constructed.

In the 20th century, machine technology peaked, and from the middle of this century onwards the power of computing power has led the world to a new revolution. During World War II, Alan Turing built the first powerful computing machine that would evolve into a modern computer. A deeper insight into the study of computing systems leads us to search for the mechanisms of human intelligence, and in particular those used for rational thinking, learning, and perception. Such knowledge that could equip the computer with people's mental abilities would allow us to build intelligent systems that exhibit the characteristics associated with intelligence in human behavior. The first two decades of the 21st century seem to implement many of those ideas that we have inherited from the last decades of the 20th century.

The essence of the educational model we call STEM is precisely based on the transition from Experience to Theory. Today a plethora of educational construction toys flood markets around the world. But how do we make any construction game a springboard to this transition?

Simple assembly exerts chiropractic skill and perception. However, the deeper cognitive content of this work is not completed at the level of perception but at the highest level of reflection, inquiry and generalization. At this last level, beyond our natural language, we need another language that is more precise and firm. It is the language of mathematics.

Through this process Mathematics acquires content by answering purely theoretical needs. Mathematics is not just calculations or drawing shapes. It is something much deeper and more meaningful. It is relationships that build on the early latent innate structures with which we are endowed since birth and that extend to the conscious structures of our later age.

Modern construction toys (modern educational tools) have all the dynamics of the transition we've talked about before in their design. What is left is to understand and highlight it.

With STEAM we can create a unified teaching model based on modern theories of epistemology and learning, with the aim of creating a clear integrated contemporary educational proposal for mathematical education and beyond. Thus, every game of any type will be continuously and thoroughly analyzed. A clear teaching proposal will be developed for each of them, which will include empirical approaches, constructive skills and theoretical deductions.