

STEAM and “ Gei-Doh (藝道) ”

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1. Technology and Art

To discuss STEAM education, it is necessary to explore the characteristics of STEM and "Art" and their relationship. The term "art" originates from the root word "*technē* in Greece," which denotes the human ability to manipulate nature. Following the industrial revolution, "art" acquired two distinct meanings: the *artificial* aspect represented by AI (artificial intelligence) and the *artistic* aspect represented by creative expression. The infusion of "art" into STEM holds significance as it activates STEM through the power of Art, which possesses contrasting characteristics to STEM (as shown in [Table 1](#)). Instead of using the term "art" with its dual meaning, I propose incorporating "Gei,藝" an artistic technique that coexists with nature, into STEM to counterbalance STEM's dominance over nature.

2. What is “ Gei” and “ Gei-doh ” ?

" Gei-doh" refers to a traditional Japanese art training system. The term "Gei", similar to "art" in English, encompasses various techniques and skills. The Chinese character for "Gei" is derived from a pictograph representing plant cultivation (as shown in [Picture 1](#)).

On the other hand, "道: *Doh* in Japanese, *Tao* in Chinese" translates literally to "road," but in this context, it represents a specific concept from traditional Chinese philosophy known as Taoism. According to Taoism, "Tao" guides individuals towards understanding the ultimate reality of the universe and recognizing the perpetual interplay of opposing elements (*yin* and *yang* 陰・陽, [Picture 2](#)). The practice of "Gei" as a skill is further enhanced through training based on the principles of "Tao."

3 “New Age Science” has met Taoism

The background of the "New Age Science" can be traced back to the counterculture movement that emerged in the United States during the 1970. This counterculture criticized the existing system, including scientific and technological dominance. Emerging fields like quantum mechanics provide a description of the "ultimate existence" in the micro-quantum world, which differs from the macro-world governed by classical physics. This concept aligns with the notions of the "Emptiness 空" in India and the "Tao 道" in China. Scholars argue that Eastern philosophies have long understood this reality akin to what the theory of quantum mechanics have found.

Capra (F. Capra, 1976) illustrates the interconversion of contradictory phenomenon such as "energy and matter, particle and wave, motion and static, existence and non-existence" within the realm of quantum mechanics. This phenomenon can be seen in the *yin-yang* conversion of Taoism (as depicted in the diagram of the supreme ultimate, Picture 2). Regarding “Gei-doh”, Capra (Capra, 1976: 112) states, "Painting and tea ceremony both require technical skills, but true mastery lies in transcending technique to achieve an unconscious artless art." This artless art is a typical situation of “Mui Shizen (無為自然),” ²signifying a state of natural spontaneity.

In the field of quantum mechanics, the act of observing nature as an object alters the object itself. It becomes impossible to objectively measure nature and predict its outcomes. Through this interplay between nature and the observer, the observer becomes aware that they are an integral part of nature, thus merging with the object of their observation.

4. Positioning of "Aesthetic (感性)" in STEAM

STEAM is expected to have a complementary effect by contrasting "art" with STEM. Table 1 provides a comparison by item. Not only Capra, but also Bohm (D. Bohm, 1980), contrasted 'yin and yang' while highlighting the distinctions between the West and the East. The West emphasized the masculine principle that corresponds to 'yang', where logic, competition, and science were preferred over cooperation and religion. However, Bohm proposed that we should now embrace and learn from the female principle (feminism) represented by 'yin', along with non-Western concepts like 'tao' and 'emptiness'. The knowledge gained from quantum mechanics has provided an opportunity to promote coexistence between humans and nature, fostering mutual understanding among diverse cultures." Regarding feminism, from the perspective of art education, the work of Pepler, Wohlwend(2018) and Liao, Motter, Patton(2016) is an example of connecting STEAM education with feminism.

A pioneer of this approach was Northrop (F. S. C. Northrop, 1946). He argued that while the West emphasizes the "theoretic continuum" of analysis based on ratio, the East emphasizes the "aesthetic continuum" based on intuition. In classical physics, theoretical analysis was sufficient, but since the advent of quantum mechanics, understanding through aesthetic and intuition has become essential in science as well. Simultaneously, he developed a theory of comparative culture to establish a world where the West and the East, science and art, democracy and communism coexist in a mutually complementary manner. I propose that the "A" in STEAM should represent a more fundamental "aesthetic" that encompasses "art" and "gei".

5. Issues in implementing STEAM education

In Japan, I expect research outcomes from collaborative research at university-affiliated schools and practical research as comprehensive learning, such as Project-Based Learning (PBL).

In STEAM education, the framework for learning content and instructional materials is composed of "science," "technology," "engineering," "mathematics," and "art/aesthetics." Mathematics, unlike STE, is a realm based on deductive reasoning from principles in the human mind, rather than inductively discovering laws from observational data and applying the laws to

technology . STE is a series of interconnected processes that elucidate the mechanisms of the material world (science), develop means for practical applications (technology), and utilize those means to manipulate the material world (engineering). These components are distinct yet intertwined, making it a challenge to present such a complex flow as instructional material.

From the perspective of learning content in art education, in the field of "engineering" that deals with real materials, such as architecture and design, sculpture and crafts, as well as scientific and artistic "handmaking craft" in primary schools, are used as teaching materials associated with STEAM. In relation to mathematics, programming as an expression tool is often said, and examples like "the golden ratio and Fibonacci numbers" demonstrate the connection between artistic form and natural form.

The textbook of practical teaching for STEAM education (Sousa & Pilecki, 2018) introduces specific teaching materials such as "the Principle of Leverage and Calder's mobile sculpture", although it does not mention the merits of art education by introducing art into STEAM education is in this book.

By contrasting art with STEM, we are once again questioning the significance of art and its role in education.

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Notes

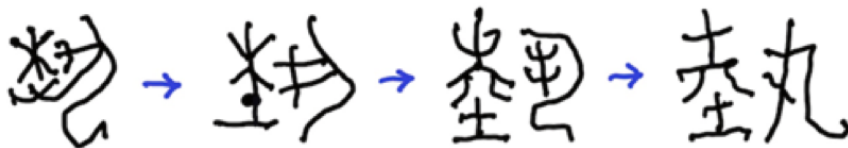
1. Tao is described as follows,

“ Tao is that by which all things become what they are. It is that with which all principles are commensurable. Principles are patterns according to which all things come into being, and Tao is the cause of their being.” in *A source Book in Chinese Philosophy*, Translated and compiled by Wing-Tsit Chan. Princeton University Press, 1963, p. 136

2. “MUI SHIZEN (無為自然) means “Nonaction does not mean doing nothing and keeping silent. Let everything be allowed to do what it naturally does so that its nature will be satisfied.” (Capra 1976: 134).

Table 1 Comparison between STEM and Art / Gei-doh

Mathematic / Science vs. Art / Gei-Doh (Aesthetic)		
①	Convergent / Analyzing	Divergent / Synthesizing
②	Universality / Reproducibility / Objectivity	Individuality / Singularity / Subjectivity
③	Necessity / Causality	Accidental / Probability
④	Theoretic / Rational	Intuitive / Aesthetic (aisthesis)
⑤	Manipulation of Numerals and Signs	Expression and Interpretation of Symbols
⑥	Artificial / Mechanic	Organic / Natural
⑦	Form / Concept	Contents / Sensibility
⑧	Order of Whole > Parts (explicate order)	Emergence by Parts > Whole (implicate order)
⑨	Consciousness	Unconsciousness
⑩	Human-Ego centric	Cosmo-Nature centric



Picture 1 「藝」 in the middle of 「藝」; Pictogram of a person crouching and planting seedlings.

Picture 2 Symbol of perpetual interplay of *yin and yang*