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The Art of Science and the Science of Art

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Abstract
If the curriculum and assessment practices in schools focused on developing the thinking processes and skills related to each discipline/ subject, students would see themselves as practitioners of each discipline and develop a continuing understanding of what practitioners in the work force experience in their daily work. To be a practitioner of a discipline, an individual has moved from a novice through competent to practitioner and sometimes an expert. The vocabulary, concepts and processes used by practitioners in the arts and the sciences are critical to develop the thinking skills needed to solve complex problems. Those complex problems involve both the arts and the sciences in their solutions. With a focus on practitioner practices and performance assessment, students would be engaged and encountering satisfying experiences as learners in school.

We think the arts and the sciences are on the opposite ends of the spectrum from each other. What does sculpting and painting have to do with research and experiments? When we look past the subjects/topics in a discipline that are central to problem solving in either the arts or the sciences, we recognize that the cognitive skills of critical and creative thinking to solve those problems are the same. daVinci stated that his four principles of education are: The art of science, the science of art, the development of the senses and the interrelatedness of everything.

When thinking about what makes a discipline, we can think about the multiple intelligences. Each intelligence has a language with a vocabulary, a conceptual framework and an intellectual process. In comparing the arts and the sciences, each discipline detects patterns, uses interpretation and reasoning to solve problems, understands relationships between information and meaning, and creates solutions to problems.

One of the most basic skills in both the arts and the sciences is observation. From observation comes inquiry. Inquiry is used to recognize what's familiar, like patterns, and what's unfamiliar. We use reasoning and interpretation to begin to solve a problem when something is unfamiliar. An example from science is observing something in a petri dish or an x-ray. It is critical for a surgeon or a chemist to see the nuance in what's observed for the success of the outcome. Visual arts education is essential for the scientist to train their eye to observe. The artist's eye sees line, shape, color – hue, value and intensity, pattern/texture and space. To see with an artist's eye is to see the nuance and detail not detected with an eye that typically sees things it can name. An example from the arts is an artist relies on observation in observing whatever interests them in the world to explore and interpret it in their artwork.

Observation is the critical first step for both the artist and scientist. The scientist's major focus becomes critical thinking to solve a scientific problem. The artist's major focus becomes creative thinking to imagine, interpret and express a visual idea. However, with both the scientist and the artist, critical and creative thinking skills are used together in their work.

We are humans who participate in the arts and sciences. As humans, we respond holistically to whatever we are doing. As you think about your work, think about how you respond critically or creatively to each step in the process to solving a problem. As an example, a ceramist begins their work by creating an object out of clay. The ceramist starts by selecting the clay that is appropriate for the size, shape and glazing of the work (art and science). There are many types of clay. The ceramist needs to know the chemical compounds of each clay to select which one that will work for the project (science). If the ceramist is throwing clay on a wheel,

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the ceramist needs to know the physics of motion, speed and pressure to control the clay as it's spinning (science). Then the ceramist can create the clay object and decorate the surface of clay to their liking (art). After the object is complete the drying and firing process takes place. The ceramist must understand the environmental conditions needed for that particular piece to dry as a whole piece without cracks or breaks (science). In the kiln, the piece must be placed and fired at the correct temperature for it' survival (science). After the clay is in its bisque state, glazing begins. The ceramist then becomes the chemist to mix which chemicals will create the glaze color and finish the ceramist desires (science and art).

The ceramist's example illustrates how seamlessly we respond to our work whether we are involved in the arts or the sciences. With a vocabulary, concepts and processes in all of the disciplines used in work and solving problems, we can honor the value of thinking like an artist and a scientist simultaneously.

The assessment processes of both the arts and the sciences are similar. Science uses scientific methods and process skills explain and problem solve: Observe, question, research, hypothesize, experiment, test the hypothesis, draw conclusions and report. In the arts, preparation is defined as a first step of assessment - identifying the goal or issue, gathering input and insight and clarifying the challenge, next is incubation – the mental process of generating ideas and finding solutions, illumination is next – the Aha moment with defining a novel solution with a prototype and strengthening a plan for action, and finally evaluating the solution and analyzing it for it's design feasibility and possibility looking for more ideas. Verification or revision is part of evaluation which is the constant assessment of investigating and assessing the artwork as it's being created. Typically we think of assessment at the end of a process or a finished product. However, assessment is a process that occurs throughout the process of creation in the arts and the sciences.

In a deeper way, finding the beauty in a mathematical problem or the aesthetic in a scientific solution and equally seeing the science in viewing the angles and perception in an artwork draws us to see the inherent value of the art of science and the science of art.

To accomplish all that's been described, performance assessment in schools is central to the work. Performance assessment involves a portfolio of work, presentations of work, and reflection as part of the learning process. A student collects their work in a discipline over time and then presents their work to others illustrating their growth, specific changes they've made (as an artist, scientist, mathematician, etc.), a piece of successful work and a piece of work they struggled with and their goals for the next time period in school. Those presentations are recorded and kept in the student's portfolio. The portfolio begins in kindergarten and goes through grade twelve. Students are given the tools needed for each discipline every year as they become more proficient in each discipline. An example, in kindergarten a student could receive three paint brushes, a ruler and scissors to begin their work as an artist.

Performance assessment provides students with a focus on who they are as artists, scientists, mathematicians, etc. and their journey in school to become more proficient in each discipline. Currently, students study the subject areas. Most students feel something is being "done unto them." Students using performance assessment throughout their education see themselves as participants in disciplines gaining more understanding and skills as they move through the grades. Performance assessment in each discipline is the type of assessment that occurs when people work in the discipline. They reflect, maintain a body of work, describe their work and are assessed on who they are as members of a discipline.

The art of science and the science of art is inherent in all that is studied in school and dealt with in the work place. Subjects in school can emphasize problem solving and the thinking skills at the center or core of each discipline. All educators can use the same thinking skills and problem-solving concepts and vocabulary to reinforce the commonalities between the arts and sciences and support the growth of students as they authentically pursue becoming a scientist, artist, mathematician, musician, athlete and more.

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