Chapter 5
NanoArt as Visual Aid in Nanoscience and Nanotechnology

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ABSTRACT

This chapter is an attempt to introduce NanoArt as a visual aid for education in Nanoscience and Nanotechnology and support the understanding of the benefits the integration of this new artistic-scientific discipline creates in a future academic curriculum. The evolution of the visibility power, advances in the visual theory which made all these developments possible, and a short primer on electron microscopy are also presented. The chapter informs about the international juried NanoArt competitions and festivals organized by NanoArt 21 and other organizations, the NanoArt presence at International Art-Science-Technology and STEAM conferences, the NanoArt K12 program, the Academy of NanoArt recently founded, and finally the Moon Museum (part of the MoonArk project) that include NanoArt works authored by 47 nanoartists from NanoArt 21 group.

INTRODUCTION

On December 29th, 1959, physicist Richard Feynman delivered his lecture "There's Plenty of Room at the Bottom," at the annual meeting of the American Physical Society at Caltech (California Institute of Technology) (Feynman, 1960). This is considered to be the starting point of the modern field of nanotechnology. He was calling for an electron microscope 100 times more powerful than the ones available at that time. However, the best resolution achieved to date is 0.05 nm (only 20 times improvement). Although this resolution is enough to see individual atoms, there is still "plenty of room at the bottom" (Feynman, 1960).

Nature, including people, is built from nanostructures (Jones, 2008). Nanoscience and Nanotechnology enable people to visualize and manipulate objects that were invisible in the past. During previous centuries, people applied nanotechnology without being aware of it because they couldn't "see" the

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nanostructures. Since the launching of the first commercial electron microscope by Siemens in 1939, the ability to measure and manipulate matter at atomic and molecular scales has led to the discovery of novel materials and phenomena.

To ease the learning difficulties associated with various concepts that exist at microscopic scale, visual models are used more frequently. Complex micro and nanostructures cannot be visualized with naked eye and students have to develop a number of new skills to be able to observe matter at this level. Visual literacy in science education is becoming a necessity due to the rapid integration of the new technologies. However, the role of visual literacy in the construction of knowledge in science education has not been investigated much (Mnguni, 2014).

VISIBILITY POWER AND VISUAL THEORY

NanoArt is strongly related to the visibility power which increased exponentially starting over 2500 years ago with the eye lens and eye loop as upgrades of the human eye, continuing in the Renaissance period with the optical microscope (the oldest optical microscope known is displayed at the Science Museum in Florence, Italy), and culminating in the late 1930s with the first commercial electron microscope, the Transmission Electron Microscope developed by Siemens.

Around 700 BC, ancient Egyptians and Mesopotamians started polishing quartz crystals as an attempt to replicate optical abilities of water. One of the most famous examples of those original lenses is Nimrud lens. Created in the ancient Assyria between 750 and 710 BC, this lens was used as decorative piece, magnifying glass, or tool for starting fires (British Museum, 2017). The earliest magnification device that has been mentioned in literature it was in Aristophanes's play The Clouds in 424 BC (Aristophanes & Walsh, 1923/2012). Roman tragedian Seneca (4 BC-65AD) is said to have used a glass globe of water as a magnifier to read ''all the books of Rome'' (King, 2003). It's been reported that monks in the middle ages used glass spheres as magnifying glasses to read. Roger Bacon described in the 13th century the properties of a magnifying glass in England.

In the 13th Century, Venetian glass blowers produced reading stones made of solid glass that was put into hand-held, single lens-type frames made of horn or wood, similar to hand-held magnifying lenses of today. Eyeglasses were developed in 13th century Italy (Kriss, T.C., & Martich Kriss, 1998). In a sermon delivered on February 23, 1306, the Dominican friar Giordano da Pisa (ca. 1255–1311) wrote, "It is not yet twenty years since there was found the art of making eyeglasses, which make for good vision... And it is so short a time that this new art, never before extant, was discovered. ... I saw the one who first discovered and practiced it, and I talked to him." (Ilardi, 2007). The first known artistic representation of the use of eyeglasses in that time is the portrait of Cardinal Hugh de Provence by Tommaso da Modena (1352). History of optics changed dramatically with Friar Salvino D'Armate's creation of the first wearable eyeglasses.

The Book of Optics by medieval Arab scholar Ibn al-Haytham for the first time claimed that the light travels in straight line and can bounce of all matter. This book remained one of the most important optic texts in the Europe between 1260-1650 (Smith, 2001). In the Book of Optics, al-Haytham claimed the existence of primary and secondary light, with primary light being the stronger or more intense of the two. According to Ibn al-Haytham's vision theory, primary light comes from self-luminous bodies and secondary light is the light that comes from accidental objects (Lindberg, 1992).