Chapter 71
Inquiry-Based Science Education and the Digital Research Triad

Dina Tsybulsky
Tel Aviv University, Israel & Mofet Institute, Israel

Ilya Levin
Tel Aviv University, Israel

ABSTRACT

The chapter deals with a new research field that has arisen at the intersection of scientific experiment and emerging digital technologies. The classical triad of experimental research 'subject-instrument-object' and its implementation in science education are in the focus of the chapter. The triad is studied in its evolution to a so-called digital triad corresponding to the experimental science of digital society. In the digital triad, each of the three components are transformed. The knowing subject - researcher is transformed to the digital scholar; the experimental instrument is transformed on the base of emerging cloud and mobile technologies; the research object comprising hybrid natural-artificial components emerges. The digital transformations of the experimental research triad and educational practices based on the digital triad are manifested in a number of pioneer inquiry-based projects analyzed in the chapter.

INTRODUCTION

Global society has transitioned into the Digital Era; this shift represents a revolution in human history – the so-called digital revolution (Dewandre, 2011; Ess, 2015; Floridi, 2014; Turner, 2006; Yuan, 2013). This revolution relates to fundamental principles of humanity. It has changed peoples' understanding of their place in the world, as people no longer merely consider humanity a part of the nature, but also a part of the artificial world that humans have created. The digital revolution also changed peoples' perception of society. Digital society is a hyper-connected one, in which people may have hundreds of acquaintances living in distant parts of the planet, with whom they exchange information. Presently,

DOI: 10.4018/978-1-5225-3417-4.ch071

moreover, people have unlimited and ubiquitous access to desirable information, which, in turn, becomes personalized and context-cognizant. Indeed, our world has become one of information abundance. This state, in contrast to the previous state of information scarcity, comprises one important characteristic of digital society (Ganascia, 2015).

Indeed, the digital era has led humanity to take on a new perspective on its surrounding environment. People are gaining an awareness of the fact that we live not only in a 'real' environment, but also in a virtual space. Such a 'twofold reality' has led to emerging technologies of augmented and mixed reality, which enable new forms of knowing the surrounding world. This phenomenon manifests another characteristic of digital society – a blurred distinction between reality and virtuality (Ess, 2015).

Within digital society, people have begun perceiving themselves as "informational organisms (inforgs), mutually connected and embedded in an informational environment (the infosphere)" (Floridi, 2014, p. 94). The concept of inforg includes not only humans but also specific informational artifacts that are able to communicate with people and even demonstrate elements of social behavior. The emerging cyber-physical systems (CPS) comprise an example of such informational artifacts, since they are hybrid systems that can be considered neither purely artificial nor purely natural. Indeed, as advanced computer-embedded systems, CPSs demonstrate one of the characteristics of digital society whereby the boundaries between people, artifacts, and nature are blurring (Ess, 2015).

Obviously, the above transformations involving such fundamental features of the human being (the emergence of the informational abundance, transforming ways of observation of the world, and a changing view on the nature of surrounding objects) could not possibly leave unchanged key components of human culture such as scientific inquiry. Needless to say, scientific experiments are changing with emerging technologies; this change contributes to an epistemological breakthrough and to the construction of knowledge (Ganascia, 2008).

In this Chapter, we address the ways in which scientists obtain new knowledge and how these new methods affect science education. We focus on the classical triad of experimental research, 'subject-instrument-object,' and study the triad in its evolution into a so-called *digital triad* corresponding to digital society. We show that the digital triad parts from the classical triad in three ways: (1) it places the subject in the role of a new type of researcher – a digital scholar and an informational organism; (2) the digital triad's emerging experimental instruments are based on mobile, wearable and mixed-reality technologies; and (3) a new type of digital objects has emerged – namely, hybrid natural-artificial objects. We apply this proposed interpretation of the digital triad to study present transformations in inquiry-based science education. We also discuss how digital transformations are manifested in certain educational ventures by analyzing a number of pioneer projects.

The Chapter is organized as follows. In the Background section, some philosophical issues connected with the Nature of Technology and the Nature of Science are discussed. In section "The research triad", the experimental research triad and its evolution are presented. Then, the detailed description of the digital triad and the interrelations 'subject-instrument-object' in digital triad are discussed. The section "The digital triad in science education" is devoted to the digital triad in inquiry-based science education. A number of educational projects that utilize the digital triad are presented. Each project demonstrates changes in a specific component of the triad.