Chapter 10
Socio-Scientific Issues and Model-Based Learning

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ABSTRACT

This chapter aims to provide a literature analysis on socio-scientific issues and model-based learning. The position of socio-scientific issues in the process of raising science literate students is indisputable. On the other hand, modeling gives students opportunities to construct their own models and use them through the learning process to formulate hypothesis, make investigations, explain scientific phenomena, and communicate and justify their ideas. Therefore, embedding modeling practice to SSI-based instruction through a framework is an innovative tool for scientific literacy in science education.

SCIENTIFIC MODELS AND MODELING

For over fifty years, modeling—and how students learn with models—has been researched in terms of philosophy of science, epistemology, and classroom practices (Harrison & Treagust, 1998; 2000). The concept of a model can be defined in many ways, but for science education, it is best explained by evaluating it in terms of various categories. A model can take one or more physical forms when published,

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even though it always exists differently in the mind of its inventor or any subsequent user. These forms can be represented in a variety of media, as stated by Gilbert and Justi (2016):

…for example, in the form of a gesture (e.g., of the relative position of objects), in a material form (e.g., a ball-and-stick representation of a crystal structure), in a visual form (e.g., as a diagram of a metabolic pathway), in a verbal form (e.g., an analogy for the structure of an atom based on that of the solar system), in a symbolic form (e.g., as a chemical equation), and in a virtual form (e.g., as a computer simulation). The range of entities that can be represented is wide: objects (e.g., of a virus), systems (e.g., of a blood circulation system), processes (e.g., of the liberation of energy from foodstuffs), events (e.g., of the attack of a white blood cell on a virus), ideas (e.g., of a vector of a force), and arrays of data about any of these entities (p. viii).

Specifically, scientific models may be a representation of a real object/process (like a model of the human skeletal system) or an abstract object/process (like an atom model) (Gilbert, 2004; Gobert & Buckley, 2000; Harrison & Treagust, 1998; Treagust, Chittleborough, & Mamiala, 2002). Therefore, scientific models can be used for different purposes in science lessons, such as to represent concrete or abstract objects/processes, to provide definitions or simplifications of complex scientific events, and to form the basis of both scientific explanations and predictions of phenomena (Gilbert, 2004; Gobert & Buckley, 2000; Harrison & Treagust, 2000).

Modeling, on the other hand, refers to a fundamental scientific practice that enables students to conceptualize, investigate, and explain natural phenomena, as well as convince others about their results (Gilbert, 2004; Harrison & Treagust, 2000). Hence, modeling is a process in which students create representations of their learning (Clement, 2000).

MODEL-BASED LEARNING

Model-based learning (MbL) is a learning and teaching approach in science education that supports learning via students' models (Louca & Zacharia, 2012). There are many studies about model-based learning from different perspectives (Louca & Zacharia, 2012). However, the authors take a constructivist perspective; they believe that learning requires individuals' creation of their own schema to assimilate new concepts (Yager, 1991). Thus, MbL approaches from constructivist learning theory are mentioned in the present chapter. The constructivist perspective argues that learning occurs through the interaction between experiences and ideas (Savin-Baden & Major, 2013). These can be externalized by the construction and transferring of models.