Chapter 8
Visualizing Condensation: Integrating Animation-Developing Technology in Chemistry Classes

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ABSTRACT

Learning chemistry involves understanding chemical phenomena at macroscopic, symbolic and submicroscopic levels. Even though chemistry instructors integrate these levels in their lessons, it cannot be assumed that students relate them properly. Therefore, it is important to identify students' mental models that will reveal how they visualize and conceptualize chemistry. Mental models can be represented in various forms including static drawing and animations. Considering the dynamic nature of chemistry, animations prepared by students can be more informative conveying students' understandings. This study aimed to investigate how high school students visualize condensation and to compare their dynamic and static mental. The analysis of the results suggested that static and dynamic mental models were found to be significantly different ($p<0.05$). Static mental models were found to be more focusing on structure whereas dynamic ones included more macroscopic features and interactions. Finally, students revised their mental models towards more accurate models after preparing animations.

INTRODUCTION

Chemistry is a science where visualizing phenomena holds the utmost importance. Processes observed in laboratories, such as gas formation, are explained by unobservable phenomena, such as structures and the interaction of particles. Therefore, visualizing the particles are necessary to understand how particular reactions take place.

Learning chemistry involves understanding chemistry at three levels: the macroscopic level of the observable and tangible; the symbolic level of equations, symbols, and mathematics; and the submicroscopic level of the molecular, atomic and kinetic (Johnstone, 1993; Taber, 2013). In chemistry classes, these three levels are integrated through various teaching methods and techniques. For instance, laboratory experiments are used to emphasize the macroscopic level, equations and formulas are used to highlight

DOI: 10.4018/978-1-4666-9616-7.ch008

the symbolic level, and computer animations or simulations are used to represent the phenomena at submicroscopic levels. Including these levels via different methods or tools doesn't mean that students can relate to them all and conceptualize chemistry accurately; they may hold misconceptions (Griffith & Preston, 1992; Harrison & Treagust, 1996). Hence, chemistry educators need to uncover students' understandings, or mental models, which are small scale representations that people have developed based on their imagination and comprehension (Craik, 1943). Mental models could be represented in the form of verbal or visual explanations conveyed orally or statically on paper. However, the nature of chemistry involves not only structures but also dynamics, such as motion, processes and interactions. Therefore, verbal explanations or static drawings will be limited for fully revealing students' understandings, because students can hardly incorporate dynamics in these representations. For this reason, animation-developing software provides appropriate environments where students create animations displaying their understanding of chemical phenomena dynamically.

This chapter discusses a study investigating students' mental models of how students visualize the physical process of the condensation of water at the submicroscopic level. Specifically, student mental models represented on paper and by animations were identified with respect to the features emphasized and compared to identify if there was a significant difference between them in terms of the aspects focused.

BACKGROUND

Understanding Chemical and Physical Phenomena

Understanding chemistry is challenging for many students because they need to conceptualize and relate chemical phenomena at three levels: macroscopic, symbolic, and submicroscopic levels (Johnstone, 1993; Taber, 2013). Students cannot easily make connections between observable changes and submicroscopic explanations (Lekhavat & Jones, 2009) and they may have misconceptions about chemical or physical processes.

Even though students observe many physical phenomena, such as evaporation and condensation, in their everyday lives, they may not have a good understanding of what is really happening at a submicroscopic level. Recent studies have shown that tertiary students have a tendency not to refer to the submicroscopic level when describing the processes of evaporation and condensation (Gobal et. al., 2004). They also exhibit a weaker understanding of condensation than of evaporation, and tend to believe that the level of an open container of water would remain constant during evaporation. Many precollege students think that during evaporation, water separates into hydrogen and oxygen atoms (Osborne & Cosgrove, 1982). Azizoglu, Alkan, and Geban (2006) reported that pre-service teachers held many misconceptions about physical changes, for example, many of them believed that the vapor pressure of a liquid depends on the volume of its container and that the freezing point is independent of pressure. Canpolat, Pinarbasi, and Sozbilir (2006) found additional misconceptions in their study of pre-service teachers, namely that they tended to believe vaporization does not begin until a liquid boils and that different liquids boiling at atmospheric pressure have different vapor pressures at their boiling points.