Chapter VI
Animations in Science Education

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ABSTRACT

The overall aim of this chapter is to explore some of the pedagogical potentials, as well as limitations, of animations displaying complex biochemical processes. As the first part of our larger research project, a learning environment was developed where visualisations by means of 3-D animations depicted some of the processes in the carbon cycle. In the analysis, we describe how three groups of students made use of and reasoned about the computer animations. In relation to the aim, three salient themes are discernible in the video material of the students' reasoning; the risk of focusing the attention on misleading aspects of the animation, the possible occurrence of a form of isolated reasoning, and the students' varying understandings of what resources they are expected to use when performing a given task.

INTRODUCTION

One of the grand themes of educational research in general and science education in particular is the notion of misconceptions. Students' misconceptions of various scientific principles are recurrent topics in numerous studies, for instance, in physics (Brown, 1992; Jones, 1991), biology (Brown, 1990; Odom, 1995), and chemistry (Goh, 1993; Nicoll, 2001; Sanger & Greenbowe, 1999). The means to meet the educational challenges spelled out by educators and educational researchers has obviously varied, but throughout the 20th century, the use of technological innovations has been an increasingly frequent strategy (Petraglia, 1998a, 1998b).

For higher biology and medical education, several digital applications have been developed.

Camp, Cameron, and Robb (1998) created virtual 3-D simulations enabling medical students to examine anatomic models, and Karr and Brady (2000) describe interactive 3-D technologies for teaching biology. Virtual learning environments for primary school (Mikropouls, Katsikis, Nikolou, & Tsakalis, 2003) and high school (Kameas, Mikropoulos, Katsikis, & Pintelas, 2000) have been developed and, in some respect, been tested out and evaluated.

Given all the time and effort invested in these matters, however, positive and stable results from the use of educational technologies are remarkably few. To underscore this observation, we would like to point to a claim by Euler and Müller (1999) who hold that, within the area of physics education, the technology known as *probeware* is the *only* computer-based learning environment that has a proven general positive learning effect. Adding to the picture that the area of physics education is intensely studied renders Euler and Müller's remark even more conspicuous. Thus, as a general pattern, students seem to be invariably immune to any simple technological treatments; despite whatever new technologies we introduce into our educational systems, *learning* continues to be a struggle for educators and students alike.

In spite of this rather gloomy outlook, ever-new items are added to the list of possible remedies of educational dilemmas and student difficulties. One item on this list and the topic of the current chapter is the use of *animations* as educational resources. Our specific field of investigation concerns secondary school science education, and the aim is to analyse the reasoning students perform when working with animated sequences of the carbon cycle.

THE CARBON CYCLE AS A TOPIC FOR EDUCATION

One of the main topics in curricula for primary and secondary schools for education of natural science is the carbon cycle and its vital importance for conditions concerning life on earth. Studies of the two main processes in the carbon cycle, *photosynthesis* (Barak, Sheva, & Gorodetsky, 1999; Cañal, 1999; Eisen & Stavy, 1993) and *respiration* (Sanders, 1993; Seymour & Longden, 1991; Songer & Mintzes, 1994) report that students' knowledge of these gaseous processes is poorly understood and that misconceptions are frequent. In consideration of the utilisation of fossil fuel and the ensuing global warming, combustion is another process in the carbon cycle deemed increasingly important. This process is chemically equal to the respiration with the exception that it is not a cellular process.

A major problem with the conceptualisation of the processes in the carbon cycle is that they involve gaseous forms that are not directly observable and therefore have to be grasped through some representational system. The traditional textbooks most often illustrate the carbon cycle in pictures furnished with arrows describing the course of the circulating material. Given an educational framing, one could conclude that there should be potential gains from developing educational material that builds on more dynamic forms of representations, for example, computer animations. From a research perspective, however, this still remains an open question. Before turning to the specific but still problematic question concerning the animation of the carbon cycle, we will briefly discuss recent work done on the use of different animations in education.

COMPUTER ANIMATIONS IN EDUCATION

The scientific results emanating from research exploring the educational value of animated graphics, as compared to the use of its static counterparts, are hitherto inconsistent. The research results so far display a complex and confusing array of outcomes in different edu-

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