

# Chapter XVII

## The Factors Affecting Multimedia–Based Inquiry

**Margus Pedaste**

*University of Tartu, Estonia*

**Tago Sarapuu**

*University of Tartu, Estonia*

### ABSTRACT

*The general aim of the present chapter is to focus on the factors influencing simulation-based computer-supported inquiry learning in small groups. The authors will give an overview of research that describes different factors influencing inquiry learning and problem solving and will add a dimension of collaborative web-based inquiry from their studies. The evidence from relevant scientific literature as well as the empirical results collected by the authors form the basis for discussion about designing an effective learning environment through a viewpoint of different end-users of our results – especially teachers and software designers. As a result, three additional main factors have been found that should be taken into account in designing support systems for problem solving: i) the level of difficulty of problems, ii) the appropriate sequence of problems, and iii) the characteristics of learners' groups.*

### INTRODUCTION

Recent research papers discuss the validity and limits of numerous experiments carried out in psychology lab settings. It has become common knowledge that authentic context is needed for making conclusions that are applicable in science classrooms (Harskamp et al., 2007; Rieber, 2005). Therefore, we carried out a series of studies in the

context of science in authentic classroom learning settings in order to detect the factors that affect students' outcomes when learning in small groups in a web-based inquiry environment. Our general aim was to give an overview how to integrate three different approaches effectively: simulation-based learning, computer-supported inquiry learning, and collaborative learning. Since simulation-based learning is regarded as a tool for collaborative and

computer-supported inquiry learning, we deal with it only briefly. Our main interest is inquiry learning in small groups.

Firstly, this chapter summarizes literature from four domains: i) computer-based simulations and ii) solving problems through inquiry, iii) applying computer-based environments for problem solving and inquiry learning, and iv) the importance of collaboration in learning. Next, we refer to our previous studies that form the basis for developing the design principles of effective web-based simulations for collaborative inquiry learning. Finally, the design principles are presented in a list of implications for both teachers and software-designers.

## **COMPUTER-BASED SIMULATIONS**

Simulations have been regarded as one of the most effective types of computer-based learning environments for more than twenty years as they give students an opportunity to clarify their understanding and misconceptions (Alessi & Trollip, 1991). Learners can manipulate different scientific models in constructing a new system of knowledge based on the old one (Brooks, 1990). Drawing direct connections between tasks in a learning environment and the real world help them to manage in solving everyday problems (Needels & Knapp, 1994). In a situational simulation, a participant is an integral part of the program and because of this, he or she can transfer more knowledge and understanding to practice in the real world. We have designed a situational learning simulation 'Hiking across Estonia' (<http://bio.edu.ee/tour/>), which provides students with an opportunity to virtually explore processes and phenomena of nature, manipulate variables, observe the effects of their operations, and make experiments to discover relations between variables. It enables students to discover the basic principles in ecology and environmental education.

## **PROBLEM SOLVING THROUGH INQUIRY**

Inquiry learning or scientific discovery has been studied for about fifty years starting with the research of Bruner et al. (1956). Unfortunately, these ideas started to spread into curricula and instructional programs, both classroom- and computer-based ones, more than thirty years later. The new era started when the ideas were developed in Klahr and Dunbar's (1988) theory of 'Scientific Discovery as Dual Search' (SDDS). This theory states that scientific discovery is a dual search between the hypothesis space and the experiment space. Besides, the modern tools in application of multimedia enable the building of appropriate support for acquiring inquiry skills in computer based environments. During inquiry, students explore new relationships between various factors for themselves and, therefore, they understand natural processes better and are able to apply this knowledge in new situations for a longer time (Zachos et al., 2000).

In a general manner, the processes of inquiry learning are divided into transformative and regulative ones (de Jong & Njoo, 1992). Transformative processes lead a learner towards the solution of a problem, step by step, whereas regulative ones are necessary for planning, monitoring, and evaluating transformative processes. It means that in inquiry learning, two parallel sets of actions are carried out and concentrating only on one of these could lead to unsuccessful problem solving. However, according to other authors, the regulative processes are embedded into a list of transformative ones and, therefore, we will describe the steps of inquiry in one sequence.

The general sequence of inquiry learning stages is the following: identifying the problem, formulating research questions, formulating hypotheses, planning the study, executing the plan, analyzing and interpreting the results, and representing findings. However, the starting point and the endpoint of inquiry of different theories

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