

# Chapter 1

*“If we teach today as we taught yesterday, we rob our children of tomorrow”*

- John Dewey [15]

## Introduction

### 1.1 What is a virtual laboratory?

A laboratory is a place that provides the opportunity for experimentation, observation or practice in a field of study [1]. By constructing a virtual laboratory using virtual reality as a medium, the above characteristics of a laboratory are augmented by a virtual simulation. A virtual laboratory provides a user with an interactive experience that facilitates the learning process in ways that were not possible up to this time. Virtual laboratories can be classified as simulation-based, learning by doing. ‘Simulation’ from virtual reality principles, and ‘learning by doing’ from education principles. A virtual laboratory is comparable to a virtual environment, however what distinguishes the former from the latter is that more emphasis is placed on education and learning. In this thesis the utilisation of virtual laboratories in education is addressed.

### 1.2 Thesis focus

This thesis focuses on the education of young learners. It discusses the educational principles of using computers as a medium of education, includes a focus on theories of teaching and learning with computers, current perspectives in educational technology, with an emphasis on virtual reality and applications of virtual laboratories in education. The main focus of the thesis is to present a generic and adaptable framework for the teacher driven development of virtual laboratories to be used in the education of young learners.

### 1.3 Thesis Layout

Chapter 2 discusses the background themes relating to virtual laboratories, such as the impact of introducing technology into an educational setting, and the learning theories and practices that underlie the educational use of computers. The types of software that have been developed for learning are also discussed. Here the focus is drawn to simulation type software, presenting virtual reality and applications in education. The chapter highlights pedagogies and learning with virtual reality, and also investigates the concerns and factors influencing the use of virtual reality in education. It discusses virtual laboratories in education by presenting constructive examples, and explores the requirements needed for the development of virtual laboratories. Techniques for evaluating, and major problems of virtual laboratories are also presented.

In Chapter 3, the theoretical approach of the Intelligent Tiles framework is presented. The chapter discusses how this framework is used for the development of a virtual laboratory, and how this virtual laboratory is used in an educational setting. The composition of a virtual environment produced with this framework is discussed. The chapter also focuses on the simulation of the virtual laboratory, presenting an approach for the behavioural and movement aspects of virtual characters, and the visual and auditory transformations of the virtual environment. How young learners can interact with and observe the simulation of the virtual laboratory is also addressed. The educational advantages of the Intelligent Tiles framework are highlighted.

In Chapter 4 the implementation of a virtual reality application implemented using the Intelligent Tiles framework is discussed. Chapter 4 presents this application, called the iTiles Ecosystem Virtual Laboratory, used for the authoring and simulation of a virtual laboratory. The development process, application program interfaces and the object oriented programming approach are presented. Implementation specifics such as texture management, 3D models, collision detection, user interface design, sound management, tile merging and camera smoothing are highlighted. The chapter also presents the tools of the implemented system. How tools are used for authoring, specifying behaviour and simulation of a virtual laboratory is discussed. These tools are presented in terms of usability and implementation, with screenshots.

Chapter 5 presents how the iTiles Ecosystem Virtual Laboratory application is used for the development of a virtual laboratory. The chapter identifies the lesson objectives for this virtual laboratory, called Drought in Africa. It discusses how the different tools of the iTiles

Ecosystem Virtual Laboratory are used, and how these lesson objectives are embedded in the authoring process. The relationships and behaviour of virtual characters specified are discussed. The chapter also discusses how the simulation of this virtual laboratory can address pedagogies in observation, mathematics and classification and offline activities. The ecological relationships and occurrences taught are also discussed.

Chapter 6 provides conclusions of the dissertation and discusses future work with regard to the Intelligent Tiles framework and iTiles Ecosystem Virtual Laboratory application.

Appendix A provides the class library used in implementation of the iTiles framework

Appendix B presents screenshots from the iTiles World Flow tool.

Appendix C presents the manual and user's guide of the iTiles Ecosystem Virtual Laboratory.

## Background

This chapter focuses on impact of technology in the education of young learners. In the first section of this chapter, the field of technology in education is explored, introducing research on the use of computers in the classroom and the impact the technology has on education. It then presents the influence on teaching and learning with computers and introduces the types of software developed for learning. Virtual reality is presented in the second half of the chapter, providing a brief introduction to virtual reality systems. Virtual reality in education is then explored, and the impact it has had on education is discussed in terms of application areas, advantageous attributes and concerns of its use. The chapter then focuses on the approach of virtual laboratories, presenting examples, techniques for evaluating them and major problems encountered with existing virtual laboratories.

### 2.1 Technology in Education

In a traditional instructional learning environment, students are expected to learn by assimilation, by listening to a lesson presented by a teacher or reading material on that subject matter. Technology provides another medium of learning whereby the computer has achieved groundbreaking results and opened up new avenues for learning. The advent of technology is not a simple exchange of old for new. Technology can change the way children think, what they learn, how they interact and how we assess them [17]. Gaining confidence in their ability to control technology is a valuable lesson children learn from computers [14]. Very young