Chapter 8
Cloud Computing for On-Demand Virtual Desktops and Labs

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ABSTRACT
Cloud computing is used to provide users with computer resources on-demand any time over the Internet. At the Hochschule Furtwangen University (HFU) students, lecturers, and researchers can leverage cloud computing to enhance their e-learning experience. This chapter presents how cloud computing provides on-demand virtual desktops for problem solving, on-demand virtual labs for special courses, and on-demand collaboration platforms to support research groups. The focus is how cloud services can be used, how they can be integrated into the existing HFU-IT infrastructure, and how new didactic models could look.

INTRODUCTION
Nowadays, the constructivism paradigm dominates the research on learning. The shift to this paradigm made its contribution to reject the belief that knowledge is passively received (Tynjälä, 1999). Rather, according to the constructivism paradigm, learners construct their knowledge by dealing actively with authentic, real life problems (Gerjets & Hesse, 2004). Furthermore, according to Gerjets and Hesse, self-controlled and cooperative activities should be supported by powerful learning environments.

Cloud computing (http://www.nist.gov/itl/cloud/), a popular trend in IT, is convenient to realize instructional principles in learning environments that follow the constructivistic view of learning, supporting on demand, self controlled
Cloud Computing for On-Demand learning environments. Currently there is no single agreed upon definition of cloud computing but one proposed by the European Telecommunications Standards Institute (ETSI, 2010) is fairly broad accepted. ETSI defines it as, “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” (p. 6). With cloud computing, several service delivery models can be realized, delivering Infrastructure, Platform and Software as a Service as a Service to support learning environments and supports an optimized utilization of the university’s IT resources, using load balancing and even over-provisioning.

In our approach, Infrastructure as a Service (IaaS) provides virtual machines (VMs) on demand for students of the Hochschule Furtwangen University. These machines are customized for courses and laboratory exercises and provisioned to build virtual laboratories. Platform as a Service (PaaS) goes a step further and offers the students of the HFU a framework to deploy their developed programming exercises on a well-defined environment. Finally, Software as a Service (SaaS) makes software services, like lecturing assist tools, project collaboration software, or development tools, available for multiple users. In summary, cloud computing allows a flexible and adaptive use of computing resources on demand (Tuncay, 2010) and thus supports powerful learning environments in terms of a constructivistic conception of learning in an effective way. Figure 1 gives an overview of the services provided to HFU students by our cloud management system CloudIA. The services are categorized into the well known cloud service model SaaS, PaaS and IaaS. Obviously, the more specialized (e.g. SaaS) the less customizable by the user.

This book chapter is structured as following: Related Work discusses work in the area of cloud computing service delivery models for e-learning, whereas in Private Cloud for E-Learning (CloudIA) the private cloud infrastructure of the HFU is described.
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