Online teaching/learning has become the main stream among higher education institutions. More and more courses in various fields have been offered online. More and more students have enrolled in online courses. On each campus, large or small, online teaching/learning systems are a key component of their education systems. For a number of the higher education institutions, a well-established online teaching/learning system is their lifeline for keeping their classes running. An online teaching/learning system depends heavily on the technologies used in constructing the system’s infrastructure. Often, an online teaching/learning system is constructed on a highly reliable network system with adequate performance. Such a system is complicated and expensive. The implementation of such a network system requires a significant amount of budget, the knowledge about various technologies, and the skills to install and manage the technologies used in the online teaching/learning system.

There have been numerous articles and books about online teaching and learning published in recent years. A few of them are about applying open source products to the support of online teaching and learning. However, it is not easy to find one that covers the development of the entire online teaching/learning system with open source products. It is difficult to find one that includes all the phases of the development process, such as requirement investigation, system modeling, system implementation with open source products, open source-based system security, open source-based system deployment, open source-based system management, and open source-based system evaluation. The open source approach has been discussed by many authors. However, the application of open source products to the development of online teaching/learning systems has not been systematically examined. To help researchers and practitioners be better informed, this book reviews studies done in recent years in the related fields.
One of the goals of this book is to improve the understanding of the development of online teaching/learning systems. The book goes through each phase of the development process and provides strategies that will help accomplish the development tasks. Especially, the book focuses on the roles played by open source products in the development process of an online teaching/learning system. For each major component in the online teaching/learning system, the book provides the information about the open source products involved in that component and describes how the open source products are used in that component. While readers make decisions, this book informs them that it is possible to construct an open source-based online teaching/learning system without using proprietary software. To help readers make their decisions, this book also provides examples, case studies, and comments to illustrate the usage of some open source tools.

The development of an online teaching/learning system needs the concepts and theory of instructional design, the skills for dealing with hardware and software, as well as the knowledge of project management and technical support. IT professionals from various fields are involved in the development and management of the online teaching/learning system. Faculty members, staff members, and students are involved in the development of the online teaching/learning system. Administrators of different levels and people who care about education are also involved in the development process.

This book is written for those who participate in the online teaching/learning system development to inform them that there is an alternative open source solution of delivering knowledge and education to the students. This book provides information for decision makers so that they can choose an appropriate online teaching/learning system for their campus.

A sophisticated online teaching/learning system does not have to be expensive. For the project manager, the book illustrates a systematic approach to the design, development, and implementation of an online teaching/learning system. The information provided in this book can also assist the project manager in financial planning, expenditure monitoring, equipment purchasing, and resource allocation. This book shows IT professionals that open source products are available to implement each component of an online teaching/learning system. The book helps the system designer to properly create a model for an online teaching/learning system before the system is implemented. It introduces some of the open source management tools that can make the online teaching/learning management more efficient and flexible.

This book shows instructors how to create online course materials in today’s Web-based teaching environment. It also provides technical details for technical personnel on system management, especially, on security management and system update strategies. The book also lets faculty members and students know that an
open source-based online teaching/learning system is as good as a proprietary-based
online teaching/learning system. All in all, this book is intended to help readers,
either a veteran project manager or a new faculty member who has just begun to
develop his/her online classes.

To implement a complex project like an online teaching/learning system with
open source products, one need to know what open source products are available and
what features are supported by these open source products. This book is designed
to address these issues too. To better understand the open source products and how
they are used to support online teaching and learning, this book closely examines the
popular open source products and compares the strengths and weaknesses of these
products. The book also provides strategies of selecting the open source products
for the tasks in each phase of the development process.

Among the open source operating systems, Linux stands out due to its popularity
and merits. This book pays more attention to the Linux operating system for both
the server side and the client side. It reviews the major Linux distributions and their
operating systems. What makes Linux important to an online teaching/learning
system is its security, reliability, and flexibility.

As a server operating system, Linux can be used to manage user accounts and to
host remote access servers. The Linux operating system is also capable of hosting
all the application software packages that are necessary to support the daily opera-
tions of an online teaching/learning system. This book reviews the server-side open
source application software such as learning management systems, Web servers,
e-mail servers, video conferencing servers, and database management systems.

To deliver knowledge through the Internet, this book reviews various network
setups and open source network protocols. For network management, the book
introduces various open source network management tools.

Security is one of the top concerns for running an online teaching/learning system.
This book examines possible security vulnerabilities of the open source teaching/
learning system and security measures that should be enforced. Some open source
security management tools are reviewed. This book provides information on how
to use these tools to protect the online teaching/learning system.

The Linux operating system can also be used as a desktop operating system on
personal computers. The desktop operating system allows students to remotely access
class Web sites for course materials and access online computer labs for hands-on
practice. The desktop operating system is also used to host application software
such as the software used to create and manage online teaching materials. This book
examines the popular Linux desktop operating system, compares its features, and
lists the application packages included in the operating system.

To help instructors create online teaching materials, this book reviews various
open source Web authoring tools, multimedia software, and collaboration utilities.
Of these open source products, the book gives detailed information on what they can do and how they can be downloaded and configured.

Through examples, this book demonstrates how Linux is used in the process of developing an online teaching/learning system. For instance, Linux is used to perform tasks such as managing network resources and student accounts, hosting Web servers, database management systems, and learning management systems, managing security, and providing remote access services. In this book, Linux is also used to create online course materials.

For the future development of online teaching/learning systems, the book gives information about the trends in technology and in e-learning that can potentially improve online teaching and learning. As always, there will be new open source products. This book discusses some new features and new trends among open source server and desktop operating systems, network technologies, database management systems, learning management systems, and security management. The book also provides information about some new technologies that are still under development.

**THE CHALLENGES**

An online teaching/learning system itself is often a Web-based enterprise-level project. Such a system is complex and versatile. A variety of technologies are involved in the construction of an online teaching/learning system which consists of servers, networks, personal computers, mobile devices, operating systems, system and network management software, security management software, remote access software, data management software, learning management software, multimedia software, collaboration software, Web development software, e-mail service software, and other application software. The daily teaching and learning activities are supported by these technologies. In addition to the support of teaching and learning, these technologies are also part of the course content covered in many technology related curricula. A sophisticated online teaching/learning system allows users to access course materials through the Internet, provides various tools for learning management, and allows students to perform hands-on practice on servers and networks. Often, a university spends a large portion of its annual budget to support such a large system. Developing and maintaining such a system is often a big challenge for many universities.

Not only is an online teaching/learning system complex, it is also a fast changing system. Each year, even each month, new technologies are released, new e-learning ideas and practice are reported, and new course materials are created. To keep up with the IT industry’s trends and to teach students the knowledge that is not obso-
lete, an online teaching/learning system needs to be updated frequently. Many of the proprietary products do not have updates before new versions of the products are released. Once a new version is released, it will cost a university to purchase the upgrades, add additional hardware and software, reconfigure the system, and provide training to users. With a proprietary product, the system upgrade is expensive and time consuming.

Given the fact that an open source-based online teaching/learning system can be the solution for many higher education institutions to support their online classes with minimum cost and with up-to-date technologies, one may assume that most of the online teaching/learning systems should be open source based. However, it is not the case in reality. Most of the higher education institutions are either not aware of the open source solution for online teaching/learning systems or may not have the personnel with the knowledge and skills to implement this type of system. Open source products are often the results of the effort of researchers and programmers. There is very little marketing effort for these products. Although many of these products are compatible with proprietary products, the decision makers and technical staff may not be fully aware of these facts.

For online teaching/learning systems, strong technical support is also a key factor. Open source tools such as those included in the Linux operating system are free and powerful enough to handle tasks such as networking and Web development. Using Linux is a great way to solve budget problems. On the other hand, Linux and other open source tools are less understood by many faculty members and administrators. Also, many technicians in technical support teams have less experience in dealing with these tools. To develop hands-on practice course materials for technology-based courses, faculty members and technical support teams need to know how to know about the features provided by open source products, how to select the open source products to achieve their goals, how to design instructional materials with these tools, and how to use open source products.

THE ANSWERS

For the development of an online teaching/learning system, based on the requirements and budget, universities have come up with various solutions. In most cases, the expenditure on technologies will increase dramatically as online teaching/learning systems become more complex and the requirements for reliability and performance get higher. The shortage of funding often hinders the effort of improving an online teaching/learning system. Among various solutions, using the open source technology to construct an infrastructure to support online teaching and learning stands out as a solution that is inexpensive and able to meet all the requirements.
By using an open source based online teaching/learning system; higher education institutions can significantly reduce the cost of developing and supporting online classes while improving reliability and performance.

For an online teaching/learning system to keep up with the IT industry’s trends and to teach students the up-to-date knowledge, open source products provide a viable solution by allowing users to add new components whenever they are available. There is no cost to obtain new versions of the products. Users can also determine which part of the product should be upgraded instead of upgrading the entire package.

To help readers better understand the application of the open source solution to the online teaching/learning system development process, this book provides the information of open source products used in each phase of the development. The book also compares some of popular open source products and their usability in an open source teaching/learning system. Since open source products will be used to support the development of an online teaching/learning system, it is helpful to provide information about this type of system. This book will address each of the key areas in the development of an online teaching/learning system.

In this book, we will discuss the design strategies, implementation methods, and the effectiveness of online teaching/learning systems. The book presents some possible solutions to the challenges encountered in the system construction and management.

ORGANIZATION OF THE BOOK

There are 12 chapters in this book. The chapters are categorized into four main sections, Introduction, Infrastructure Development for Offering Online Courses, Course Material Development for Online Courses, and Trends and Advances. The following is a brief description of each section.

**Section 1: Introduction.** This is an introduction section that includes three chapters. This section provides an overview of open source products. As the title of the book indicates, the open source products are used to support the development of online teaching/learning systems. To help readers understand how to properly apply the open source products to the development of an online teaching/learning system, this section also introduces the theories of instructional design and instructional technology, and the solution development procedure. The instructional design model ADDIE will be used as a guideline for the system’s development.

The first chapter provides an overview of the open source technology. This chapter gives the background information of the open source approach. In the overview, this chapter will explain the concept of open source and what open source tools
are available for online teaching and learning. It gives a brief history of the open source technology. This chapter also investigates the current usage of open source products in education institutions. It discusses the strengths and weaknesses of the open source products and the roles that can be played by these open source products in developing an open source online teaching/learning system.

The second chapter reviews the instructional technology theory in general. Developing an online teaching/learning system is a complex process that needs to be thoroughly planned. Such a system must be carefully designed before it can be implemented. Since one of the book’s goals is to show how to apply the open source tools to the development and management of online courses, the theory of instructional technology is introduced in this chapter as a guideline for the development process. Based on the theory of instructional technology, the development of an online teaching/learning process is divided into five phases, needs analysis, system design, system development, system implementation, and system evaluation. In this chapter, topics related to these five phases are covered.

Chapter III provides the technology requirement analysis. It describes the methods of conducting the requirement analysis. This chapter explains how to collect information and how to analyze the collected information. It covers the requirement analysis for computer systems, networks, learning management systems, application software, collaboration tools, and course material development.

**Section II: Infrastructure Development for Offering Online Courses.** This section discusses the components in an online teaching/learning system. It includes six chapters. Each chapter covers a major component. Based on the analysis conducted in Chapter III, the open source products are reviewed for each component of an online teaching/learning system.

Chapter IV introduces the network infrastructure for an online teaching/learning system. Based on the technology requirement analysis, Chapter IV examines the network related open source tools that can be used to achieve the design goal. The first topic discussed in Chapter IV is the client-server architecture on which an online teaching/learning system will be developed. Then, this chapter looks into network equipment. The next topic to be covered in this chapter is about the network management related open source tools. Lastly, this chapter demonstrates the network development process for an online teaching/learning system.

Chapter V is devoted to the discussion of server technology. Servers are used to deliver course materials and other services to students. Chapter V discusses the issues related to computer systems on the server side. Linux as a server operating system is the main topic in this chapter. Linux Enterprise Server is an open source network operating system that is used to handle network resources as well as application software. Servers handle remote access through the Internet. This chapter examines some of the server equipment that supports the Linux operating system.
The next topic covered in this chapter is the investigation of open source system management tools, especially those included in the Linux operating system. This chapter also introduces various virtual server technologies that play an important role in online computer lab management. The last part of this chapter demonstrates a server development process with open source products.

Chapter VI is focused on database system development. This chapter starts with the review of open source database management systems. Then, it discusses some of the database design, development, and implementation-related issues. It looks at database management and explores the open source tools for database management. Lastly, this chapter gives an example of installing and configuring the database management system MySQL on a server with the Linux operating system installed.

Chapter VII covers the topics related to open source learning management system (LMS) software packages. An LMS is commonly used to support course setup, management, and assessment. Many LMS software packages can also provide tools for developing multimedia course materials and tools for collaboration. This chapter compares several popular open source LMS packages. The last part of this chapter shows an example of the installation and configuration of an LMS on a Linux server.

Chapter VIII deals with the security management of an online teaching/learning system. Security is very important to online teaching and learning. This chapter examines security policies for online teaching/learning systems. It goes over the process of creating a well defined security policy. This chapter also discusses the issues related to vulnerability assessment. It investigates security vulnerabilities and explores some of the open source vulnerability assessment tools. It also explores other open source security tools used to enforce various security measures. Then, examples are given on the security management with the Linux operating system.

Chapter IX discusses open source computer systems and tools for the client side of an online teaching/learning system. The Linux desktop operating system is the main focus. This chapter also examines the open source tools for the management of the Linux desktop operating system. In addition to the desktop management tools provided by the Linux operating system, the chapter also reviews other open source desktop management tools. The last topic in this chapter is about the open source remote access tools. The configuration of some open source remote access tools is demonstrated.

Section III: Course Material Development for Online Courses. This section covers the issues related to developing course materials with open source products. Two chapters, Chapter X and Chapter XI are included in this section.

Chapter X focuses on the development of course materials with the open source tools. The theories of instructional design and instructional technology are used to guide the development process. By following the instructional design model ADDIE,
this chapter illustrates how the open source tools are used to develop course materials. This chapter gives some detailed discussion on the open source Web authoring, multimedia, and collaboration tools. The last part of this chapter presents an example to illustrate how the open source tools are used to develop course materials to meet the objectives required by the instructional design.

Chapter XI deals with the issues of implementation and evaluation which are part of the ADDIE model. After the online teaching materials are developed, the next task is to deploy the teaching materials. Since the Web server and student accounts are managed by the computer service department, the strong support from computer service is the key for a successful deployment. This chapter discusses technical support and training which belong to daily maintenance. The improvement of the online teaching/learning system should be based on the feedback from the users. The response from the instructors and students can be used as a guideline for identifying the areas that need to be improved. The last topic in Chapter XI discusses the evaluation of online courses and course materials.

Section IV: Trends and Advances. This section has one chapter, Chapter XII, which is about the trends in the development of online teaching/learning systems.

Chapter XII provides information about some of the trends in open source products and other technologies that have a potential impact on the development of online teaching/learning systems. This chapter points out some of the recent changes in instructional technology. It describes the possible use of the newly developed open source products for online teaching/learning systems.