Advances in Computer-Supported Learning

Francisco Milton Mendes Neto
Federal Service of Data Processing, Brazil

Francisco Vilar Brasileiro
Federal University of Campina Grande, Brazil

Information Science Publishing
Hershey • London • Melbourne • Singapore

Chapter IV

Learning Management Systems: An Overview and Roadmap of the Systemic Application of Computers to Education

William R. Watson,
Indiana University - Purdue University Indianapolis, USA

Sunnie Lee, Indiana University, USA

Charles M. Reigeluth, Indiana University, USA

Abstract

This chapter discusses learning management systems (LMS) as a technology necessary for supporting the educational needs of the information age. It defines LMS and argues that the move from the mechanistic, sorting-oriented paradigm of the industrial age to the customized, learning-oriented paradigm of the information age requires the application of LMSs to succeed. The history of LMS is presented and the definition further clarified by comparing and contrasting LMS with course management systems (CMS), learning content management systems (LCMS) and learning objects. Several major K-12 LMSs are presented, evaluated, and their features compared. Finally, the current trends of LMS are discussed, and goals for further development are offered. A better understanding of LMS, its role in the new paradigm, and the areas where it needs to improve and continue to grow are essential to improving the effectiveness of education in the information age.

Introduction

The potential impact of computers on learning has been recognized since well before the widespread adoption of the technology itself. With a history dating back to the 1950s, computers have been used to assist with or even directly provide instruction to learners (Reiser, 1987). Learning management system (LMS) is a relatively recently coined term that refers to computer systems that incorporate providing instruction, tracking achievement, and managing resources for individual students and an organization as a whole. This chapter defines LMS, discusses the pressing need for LMS technology in the emerging knowledge-based paradigm of education, and examines the history of LMS and how it has developed from, and differs from, past computer learning technologies. LMS is then compared to other computer learning technologies and related concepts, after which four popular K-12 LMS products are described and evaluated. The chapter concludes with a discussion of the current state of LMS, what trends exist in the further development of LMS, and what needs LMS must meet in order to satisfy the requirements of the information-age paradigm of education.

Definition of LMS

Learning management system (LMS) is a generic term often used to describe a number of different types of computerized training and instructional systems. Essentially, an LMS is an infrastructure that supports the delivery and management of instructional content, the identification and assessment of individual and organizational learning goals, and the management of the progression toward meeting those goals, while providing data for the supervision of the organization as a whole (Szabo & Flesher, 2002). To differentiate LMS from the sea of acronym-driven computer learning technologies in the literature, it is important to understand the systemic scope of LMS. An LMS, as Gilhooly (2001) states, "goes beyond basic content delivery to offer course administration, registration, tracking, reporting and skills gap analysis" (p. 52). General characteristics include the following:

Copyright © 2007, Idea Group Inc. Copying or distributing in print or electronic forms without written permission of Idea Group Inc. is prohibited.

- instructional objectives are specified with individual lessons;
- lessons are integrated into the standardized curriculum;
- courseware extends several grade levels in a consistent manner;
- a management system collects and records the results of student performance; and
- lessons are provided based on individual students' learning progress. (Bailey, 1993)

Need for LMS

There have been a substantial number of publications discussing the shift of society from the Industrial Age into what many call the Information Age (Reigeluth, 1994; Senge, Cambron-McCabe, Lucas, Smith, Dutton, & Kleiner, 2000; Toffler, 1984). In order for our schools to meet the needs of today's learners, the way in which the schools function must also change dramatically and systemically to focus on individual learners' needs (Reigeluth, 1994; Reigeluth & Garfinkle, 1994; Senge et al., 2000).

The current educational system was built to fit the image of the industrial-age society, in which learning is highly compartmentalized into subject areas and students are "treated as if they are all the same and are all expected to do the same things at the same time" (Reigeluth, 1994, p. 204). Furthermore, much of the onus for learning is laid at the feet of teachers rather than the students themselves, and students do not take an active role in either their own learning or the school community as a whole. The current industrial model of education places an emphasis on sorting students rather than developing their knowledge. A fixed amount of content is presented in a fixed amount of time, and students must move on, whether they have learned it or not. Students are divided into grade levels with classes in which they learn the same things at the same time. This forces "achievement to vary among students, with the consequence that the low-achieving ones gradually accumulate deficits in learning that handicap them in their future learning endeavors" (Reigeluth, 1997, p. 204), while high-achieving students are held back and lose interest. The system is not designed to promote student learning; it is designed to select students. In the industrial age, it was important to separate the laborers from the managers, and educating the common laborers was not economical and, indeed, was not desired, for they would not be content doing the repetitious and dull tasks that their jobs at the assembly lines would require (Joseph & Reigeluth, 2002).

However, today the mechanistic, unthinking jobs of the assembly line have largely disappeared, and employers are now looking more and more for problem-

solving employees with initiative and a variety of skills to work effectively as a part of a team. These requirements reflect a need, in the information age, for expanded mental capabilities, which greatly increases the importance of student learning. The focus of education must shift from student sorting to student learning, and therefore, certain changes are required to truly help students learn. Since it is known that children learn at different rates and have different learning needs, even from the first day of class, it does not make sense to hold time constant and thereby force achievement to vary. Apart from not meeting the needs of society at large, it is an inhumane treatment of the children to not focus on helping all children to reach their potential. The alternative to holding time constant is to hold achievement constant at a mastery level, and allow children to take as much time as needed to reach that level. This requires the educational system to move from a process of standardization that results in high failure rates to a completely new paradigm that supports customization in order to meet all learners' needs.

This new paradigm for information-age-appropriate education will require significant changes in the use of time, talent, and technology (Schlechty, 1991). The changes in use of time entail not only allowing each student as much time as needed to achieve mastery, but also allowing each student to move on as soon as he or she reaches a mastery level. This means that the pace of instruction will be customized to help meet each student's needs.

Schlechty (1991) also argues that the use of talent will need to be altered. Talent refers to the roles that both students and teachers play. The role of teachers will change substantially as instruction moves to a more learner-centered approach (McCombs & Whisler, 1997). Teachers will become facilitators of knowledge acquisition by acting as guides, coaches, and motivators for students. No longer will the teacher be the primary source of knowledge, a talking head, but instead the teacher will help each student to find appropriate materials for acquiring the desired knowledge. This shift in roles will also place new demands on the student. Students will be required to be active learners, assuming the responsibility to take initiative and be more self-directed as they gain knowledge.

The third shift that Schechty (1991) argues will be necessary in the new paradigm of education involves the use of technology. First, with learner-centered, custom-paced instruction, technology is needed to track what each learner has mastered. This will allow teachers to easily keep records of each student's progress and thereby provide appropriate guidance to each student. Second, decisions about what to learn next (i.e., the sequencing of instruction) for each student will also be important, and technology will need to play a central role in helping student and teacher decide what should be learned next. Third, as teachers move from being the sole source of instruction to being guides or coaches, technology will be needed to help instruct the students by providing content, often in more interactive ways than have traditionally been used. Simulations and instructional games can provide interactive content, give immediate feedback, diagnose student needs, and provide effective remediation. Fourth, technology will also be needed to help in the assessment of student knowledge to certify student mastery and store examples of student work that represent their attainments (e.g., portfolios). Finally, technology will need to provide a systemic integration of all of these features.

In essence, an information-age, learner-centered paradigm of education cannot be effectively implemented without technology, and by the same token, technology cannot approach its potential contribution to education and learning without a learner-centered paradigm of education.

Fortunately, computing is becoming more ubiquitous every day, and a major part of the information-age classroom will be the use of advanced technology to meet the five needs just listed. Instructional technology has shown promising results in evaluation studies conducted during the 1960s to 1980s, and technology is widely used in schools these days. In envisioning the information-age school, "technology will play central roles in teaching, assessment, and keeping track of learner progress…" (Reigeluth & Garfinkle, 1994). LMSs promise an integrated tool for serving the five major functions that are needed for technology in information-age schools.

History of LMS

LMS has evolved through a history of various applications of computer technology to instruction. These applications have been described with various terms, many of them generic. Computer-based instruction (CBI), computer-assisted instruction (CAI), and computer-assisted learning (CAL) are all generic terms that have been used to describe different applications of computers to instruction. While there are not specific definitions for these terms, Parr and Fung report that generally, CAI is typically used to describe drill-and-practice programs, CAL includes more sophisticated tutorial instruction, and CBI places more emphasis on individualized instruction (Parr & Fung, 2001). More differentiated from these other terms are integrated learning system (ILS) and computer-mediated instruction (CMI) which include such additional functionality as a management and tracking system on top of the instructional content, integration across the system, and greater focus on personalized instruction (Bailey, 1993; Becker, 1993; Brush, Armstrong, Barbrow, & Ulintz, 1999; Szabo & Flesher, 2002).

In the early 1980s, many classroom teachers and administrators turned away from ILSs because they appeared to be the same old products in new packaging. Most of these educators were primarily skeptical about how individualized instruction and computer-assisted instruction came and went with other educational trends of the 1960s and 1970s. But as more sophisticated ILS software began to address problems associated with individualizing instruction, it began to show greater potential to improve learning and teaching, and it evolved into a more holistic learning and data management system. Now, LMS takes these additional components even further in helping to "manage the entire instructional program and learning process" of an organization (Szabo & Flesher, 2002). Further, LMS is systemic in nature, covering both learning and e-learning programs and processes. It is this systemic nature that differentiates LMS from much of the other educational software available, in that it is neither simply a collection of instructional software nor only a student assessment tracking platform, but is instead truly systemic in addressing all aspects of the instructional process.

LMS' Relation to Course and Content Management Systems and to Learning Objects

While we have addressed the definition of LMS and further detailed this definition by looking at the history of LMS and its relation to past computer learning technologies, it is important to also discuss the role of LMS amongst other related advancements in computer learning technologies. These include course management system (CMS), learning content management system (LCMS), and learning object (LO). While LMS is often used synonymously with CMS and LCMS and is conceptually seen as having equivalent goals as LO, LMS is again differentiated by its scope, and this section explores how LMS is related and impacted by these technologies due to its systemic incorporation of them.

Course Management System

One technology that is often confused with LMS is CMS. The systemic nature of LMS previously discussed differentiates LMS from CMS. A CMS is a tool that focuses on the management of one or more courses, typically by an instructor, and is usually used for distance education or hybrid (both face-to-face and distance) courses. As defined by the EduTools[1] Web site, a CMS excludes:

Single function software like stand-alone assessment tools, synchronous tools or authoring packages that do not also have many other features or act as part of a larger suite that delivers online education courses, and course content materials and course content bundled with its own online delivery system. (Leslie, 2003[2])

A CMS is a tool that just helps an instructor to manage individual courses, rather than also providing a system-wide tool. Its function is defined as: "it provides an instructor with a set of tools and a framework that allows the relatively easy creation of online course content and the subsequent teaching and management of that course including various interactions with students taking the course" (EDUCAUSE Evolving Technologies Committee, 2003, p. 1). Examples of a CMS include Blackboard, WebCT, Angel, and Oncourse.

Learning Content Management System

LCMS is often used either synonymously with LMS or touted as a newer version of LMS. However, the focus on content is the key to understanding the difference between these two technologies and seeing how they relate. Oakes (2002) reports that the IDC defines LCMS as a system that is "used to create, store, assemble and deliver personalized e-learning content in the form of learning objects" (p. 73). So, the focus with LCMS is on content: "it tackles the challenges of creating, reusing, managing, and delivering content" (Oakes, 2002, p. 74). While LCMS focuses on content, an LMS is "learner and organization focused: It's concerned with the logistics of managing learners, learning activities, and the competency mapping of an organization" (Oakes, 2002, p. 74). Connolly (2001) echoes this, stating that while LMS and LCMS complement each other, the "LMS provides the rules and the LCMS provides the content" (p. 58).

Learning Object

Learning object has become a highly visible buzz-word in education recently and is taking its place as the favored technology for the future, based on its promise for reusability (ability for instruction to be reused in multiple contexts), generativity (the ability to generate instruction), adaptability (ability to be adapted to individual learners), and scalability (ability to be extended to both larger and smaller

audiences without a substantial increase in cost) (Gibbons, Nelson, & Richards, 2002; Hodgins, 2002; Wiley, 2002).

While learning object is fairly consistent in its promise of instructional design that reduces costs and produces instruction that is adaptable to individual learners and contexts, the actual definition of learning object remains unclear. Learning object has been used to describe everything from a textbook to a computer image to an instructional simulation or video game. Furthermore, terms other than learning object are sometimes used to describe what appear to be learning objects, such as MERLOT's use of "online learning materials," or Merrill's use of "knowledge objects" (MERLOT, 2005; Merrill, 2002). Parrish (2004) notes that the Institute of Electrical and Electronics Engineers (IEEE) provided the vague definition of a learning object as "any entity, digital or nondigital, that may be used for learning, education, or training" (p. 52). Wiley (2002) notes how this definition does not exclude anything related to instruction of any type. He therefore proposes his own definition of a learning object as "any digital resource that can be reused to support learning" (2002, p. 3).

This definition seems to be more on par with the general definition of a learning object as a reusable digital artifact that can be used in learning. However, Parrish (2004) argues that this definition does not eliminate software tools a student might use, such as a calculator or word-processing program. He instead argues for defining learning object in terms of its use or function: "instructional content becomes a learning object when it is used as a learning object" (p. 52).

While Parrish's arguments have some merit, and it is certainly unclear whether Wiley intends to include instructional tools in his definition as well as instructional content, it seems that Parrish's approach might result in more confusion in the long run among those unfamiliar with object-oriented concepts. However, Wiley's use of the term "resource" to describe the object itself could cause some confusion. The key elements of learning objects that lie behind much of the discussion would seem to be the ideas of learning and reusable artifacts. These artifacts would not typically include tools; therefore, Wiley's definition would be more precise if it referred to digital "media" rather than digital "resource." This clarification seems to capture the key concepts and the general understanding of learning objects and their benefits without requiring a more expert understanding of the object-oriented design process that Parrish's definition calls for. Furthermore, Parrish (2004) admits that, while the concept of breaking instructional systems intro smaller reusable objects and methods is related to learning object creation, he points out that learning is different than computer programming, and the concepts of object-oriented programming are not a perfect fit to the instructional design of learning objects.

It should be clear that learning object, while related to LMS, certainly exists at a much narrower scope than LMS. While the key component of LMS is its systemic nature, a key feature of learning object is its modularity, discreteness, and reusable nature.

The Interconnectedness of Learning Object, CMS, LCMS, LMS, and Associated Challenges

This section has shown the close relationship between learning object, CMS, LCMS, and LMS. The role of LMS as a systemic manager of the included technologies places a focus on scope when seeking to understand the differences among these kinds of tools. Furthermore, just as the LMS encompasses the other technologies, learning objects by definition exist as the smallest discrete components of all of these technologies; they make up the reusable instructional content that is managed by an LCMS and are plugged into the courses managed by a CMS, both of which are pieces of the larger, systemic LMS. To be reusable, learning objects by nature need to be distinct. Therefore, to better understand how all of these technologies tie together to form an LMS, it is important to also examine the challenges that exist with the creation, sharing, and use of learning objects.

There are several current challenges to the implementation of learning objects. Foremost among these problems is the need for standards to allow learning objects to be reusable and searchable across different educational systems. A key component in this search for standards is meta-data, which is used to describe the learning object and make it accessible. Without a standard for meta-data, even if a learning object is made to be reusable, it is unlikely to be reused, simply because access to it is severely limited by the lack of meta-data. Unfortunately, there are many current standards being applied to the creation of learning objects, including LOM, CanCore, and SCORM. The lack of standards for learning objects causes a trickle down effect which negatively impacts LMSs.

Just as there are many standards for learning objects, there are also several standards "for evaluating interoperability between LMSs and content" (Connolly, 2001, p. 57), mainly SCORM and the Aviation Industry CBT Committee (AICC) standard. Furthermore, there is also no agreement as to exactly what LMSs must do to be compliant with the standards that exist, as each of these standards has multiple levels of compliance (Alexander, 2001). Ultimately, confusion aside, one large problem with applying standards is the inherent cost. Much of the content being used by LMSs was developed well before standards existed or have never had standards applied. Furthermore, content providers have their own proprietary software development tools that do not support standards, so the cost of converting old content to meet standards, and acquiring industry

development tools which support compliance with standards, can be prohibitive.

Finally, there is the issue of what kind of instruction is promoted by learning objects and LCMS. Parrish (2004) cites Wilson's 2001 discussion of the spectrum in distance education where one trend focuses on automation, standards, and control (the old practice of "drill and kill" software), while the other end of the spectrum points toward open systems and learner-centered approaches. If a strong reason for the use of computers in the classroom is to use the processing and tracking power they offer in order to help customize learning, then perhaps the learning objects being created should be modifiable by students or their instructors in order to help establish learning environments that allow for exploration and the building of knowledge, as opposed to the limited interactivity of assessing the ability to regurgitate static facts (Parrish, 2004).

Much of the learning software used today promises personalization but does not deliver outside of the barest sense of students being able to move through static instruction at their own pace, while the system assesses their progress. LMSs today are based somewhat on the concept of learning objects, in that they present digital instruction that can be tailored to state and federal educational standards and therefore can be sold to schools across the world. The reusable nature of these learning objects shows the successful promise of learning objects while at the same time going against the notion of an open environment by charging schools for access to the objects. Many of the current LMSs available to schools in the United States are offered by companies with a long history of creating digital instructional modules for their customers. These modules are essentially composed of the learning objects that the LMSs are reusing. The LMS then provides additional features, to support students' learning such as assessing the student's performance and customizing the sequencing of additional objects. While LMS and its various components face challenges, it also holds a great deal of promise, and some applications offer features that are well-suited for a learning-focused paradigm of education. A better understanding of the nature of existing LMSs can be reached by examining the various features currently offered by the major K-12 LMS products available in the United States, as well as looking at existing research into their application.

Comparison and Evaluation of Existing LMSs

This section presents and compares the major features of a number of LMSs available today for K-12 schools, and it provides a general overview of the evaluative research that has been conducted on those LMSs. Since these LMSs are highly complex systems, the number of features they possess is so large as to be unmanageable in a review such as this. Therefore, a conceptual framework of major features is presented to facilitate this description and comparison of features. Table 1 shows the features identified from our analysis of LMSs that seem to be the most important for understanding them.

It is helpful to note the features that are particularly well-suited to meeting the needs of the information age, for some of the LMSs were developed to meet the needs of the sorting-focused paradigm of education. However, it is likely that these products will continue to develop and move toward providing true, systemic, integrated, learner-centered features such as: customizable, unique instructional content, individual pacing, assessment of individual learning gaps, addressing those gaps, and further involving students and their parents in learning.

The LMSs examined are some of the largest LMSs available in the United States: PLATO, Pearson Digital Learning, SkillsTutor, and Co-nect. The sheer number of educational programs under the umbrella of a larger product system makes the comprehension of what each product offers daunting. Pack (2002) states that one of the first hurdles to implementing a new program is "sifting through the multitude of proffered solutions" (p. 23). He references e-learning analyst Bryan Chapman, who states that, at that time, there were more than 650 vendors of e-learning products. While the trend has been the merger and absorption of products into the larger LMS companies, it can still be very confusing trying to sort out what each product actually does. Pack (2002) quotes Healy, a research analyst for education and training, who describes the market: "It's just a big mess… There are way too many platforms and solutions right now. There's a lot of confusion on the buyer's side" (p. 23). Further complicating this is the focus on industry buzz-words and the use of marketing language common in the literature of these companies, which makes it difficult to determine if the products truly offer, or to what degree they offer, certain features, such as customizable instruction. This section reports the results of a determined attempt to sift through the morass of information and present a comparison of several of the major current LMSs for K-12 schools.

PLATO

PLATO is currently one of the largest LMSs used in K-12 schools and governmental institutions in the United States. The LMS PLATO was initially designed as a CMI system for use with PLATO, which was at the time a mainframe system completely devoted to the delivery of instruction and training. This system was designed to work with other curricula and to manage other courseware in the corporation. Another CMI system was custom-developed for

Table 1. Major features of LMS

Features (grayed features support information-age needs)		
Instructional Method	Standard features	Content presentation
		Curriculum standards
		Direct instruction
		Bilingual
		Self-paced learning
		Project-based work
		Group work
		Authentic, real-world problems
		Individualized instruction
	Teacher customizability	Adaptive sequencing
		Adaptive lesson plans
		Customizable instructional content
		Prescription of lessons
	Outside school	Online message center
		Online discussion board
		Project-based work
		Activities/homework with parent involvement
		Community relations and support
		Online lesson plan management for teachers
Data management		Attendance
		Health information
		Parent/guardian information
		Enrollment
		Class schedule
		Record of attainments mastered
		Mastery progress
Assessment		Post test / Pre test
		Formative tests
		Practice tests
		Diagnostic tests
		Mastery-level tests
Reporting		Summative test report to teachers/ parents
		Formative test report to teachers/ parents
		Student information report to teachers/ parents
		Record of attainments report to teachers/ parents
		Mastery progress report to teachers/ parents
		Customizable reporting for teachers

the University of Illinois PLATO system, which later became the original system of CDC PLATO (Szabo & Flesher, 2002).

The PLATO system provides a wide variety of instructional programs, as well as district software and assessment and reporting tools. The products are organized into three categories: accountability solutions, assessment solutions, and instructional solutions (PLATO, Inc., 2005).

PLATO's accountability solutions include data warehousing and synchronization tools, standards and curriculum integration tools, and a collection of communication tools and resources called the PLATO Network. Together, these tools allow local standards to be defined; assessments to be associated with specific standards; student, school, district, and professional data to be collected, stored, and managed; and communication to be promoted among members of the learning community (including students and their families) through the sharing of information and resources.

PLATO's assessment solutions provide a wide variety of testing products, many of which are tied directly to PLATO instructional products. Students may take practice tests, have their learning assessed and learning gaps identified, and either have a PLATO curriculum path automatically generated or have a customized path developed for them by their teacher. PLATO also provides teachers a way to create their own assessments in addition to providing practice for such tests as the National Writing Test, the GED, and the Pre Professional Skills Test, as well as a practice test for helping paraprofessionals meet the testing requirements of the No Child Left Behind Act of 2002.

The instructional programs are for elementary, secondary, and post-secondary grade levels. Subjects include reading, writing, mathematics, science, social studies, and life and career skills, as well as interdisciplinary and ESL/ELL curriculum in Spanish. Plato focuses on providing self-paced, individualized learning environments with tutorials and practice opportunities that are highly integrated with curriculum standards. With a 30-year heritage of research and development, PLATO claims that it strives to constantly evolve and grow to realize learner-centered, information-age education (Foshay, 1998). In summary, Table 2[3] shows the features that PLATO seems to offer, though we advise that these ratings be interpreted with caution, and many features are a matter of degree rather than yes-no.

PLATO has a large body of evaluation studies, mostly conducted by PLATO's own evaluators and evaluation consultants from research laboratories. Foshay conducted a meta-analysis of 13 PLATO evaluation research studies conducted from 1993 to 2001. The study's target populations included urban, suburban and rural, underachieving, low-income populations in elementary, secondary, and post-secondary education settings. The analysis showed improvements up to 60% on achievement of standards. The pass rates on state exit exams ranged up to 85% in English and 100% in math.

Kulik (2003) also conducted a meta-analysis on 20 studies of PLATO based on Foshay's analysis conducted in 2002. The evidence reviewed in this report provides support for the effectiveness of PLATO learning products, both as supplementary and as the only instruction compared to low-tech, traditional instruction alone. However, there were eight studies using a control group which

Kulik identified as providing the most reliable data. In these studies, which used an experimental group receiving solely PLATO instruction and a control group receiving only conventional instruction, the average effect size Kulik found was 0.43, which suggests positive effects of PLATO. However, as Foshay (2002) points out, the relationships between achievement and time on task with PLATO are complex, and the effects of PLATO were never measured in isolation from

Table 2. Major features of PLATO

Features (grayed features support information-age needs)			PLATO
Instructional Method	Standard features	Content presentation	✓
		Curriculum standards	✓
		Direct instruction	
		Bilingual	✓
		Self-paced learning	✓
		Project-based work	
		Group work	
		Authentic, real-world problems	
		Individualized instruction	✓
	Teacher customizability	Adaptive sequencing	✓
		Adaptive lesson plans	
		Customizable instructional content	
		Prescription of lessons	✓
	Outside school	Online message center	
		Online discussion board	
		Project-based work	
		Activities/homework with parent involvement	✓
		Community relations and support	✓
		Online lesson plan management for teachers	
Data management		Attendance	
		Health information	
		Parent/guardian information	
		Enrollment	
		Class schedule	
		Record of attainments mastered	✓
		Mastery progress	✓
Assessment		Post test / Pre test	✓
		Formative tests	
		Practice tests	✓
		Diagnostic tests	✓
		Mastery-level tests	✓
Reporting		Summative test report to teachers/ parents	✓
		Formative test report to teachers/ parents	✓
		Student information report to teachers/ parents	
		Record of attainments report to teachers/ parents	✓
		Mastery progress report to teachers/ parents	✓
		Customizable reporting for teachers	

these various influences; therefore, it is hard to evaluate the independent effectiveness of the PLATO system.

Pearson Digital Learning

Pearson Digital Learning is another large LMS currently widely used in schools. It provides a number of instructional programs as well as district-wide reporting software, assessment tools, and reporting tools. The broadly used instructional programs are Waterford, SuccessMaker, KnowledgeBox, and Novanet. Pearson Digital Learning offers a series of programs for student data, which include SASI, Pearson Centerpoint, and CIMS. Pearson Digital Learning also has a new division, Pearson School Systems, which produces enterprise software covering everything from student data and assessment, to decision support systems, to human resources and finance tools.

Waterford. Waterford focuses on the pre-kindergarten to 2 age group with reading, math, and science instruction adapted to each learner. It provides year-long instruction, from beginner to mastery, for classroom activities and take-home assignments. It also provides multimedia instruction. The Waterford Early Reading Program is a software-based curriculum currently serving over 13,000 sites and 350,000 students with three levels of full-year instruction. The Waterford Early Math and Science Program also serve three levels of full-year, computer-based curriculum aligned to the National Council for Teachers in Mathematics and National Science Education standards (Pearson, Inc., 2005).

Several studies have been conducted by independent evaluators on the effectiveness of the Waterford program. The Education Commission of the States (1999) reported evaluation results stating that overall Waterford had a positive impact on student performance, particularly with limited or low performing students, compared to traditional instruction. Studies conducted on the Waterford Reading program at Rutgers University in New Jersey and the Dallas Independent School District in Texas both showed results for the Waterford classes outperforming the control group by highly significant differences.

SuccessMaker. SuccessMaker incorporates subjects such as English language development/ESL, mathematics, science, and social studies into the curriculum. SuccessMaker focuses on individualized, adaptive instruction for standards-based curriculum by adapting sequences for individual students and presenting instruction based on previous student assessment. SuccessMaker also provides flexible group work, authentic literature, bilingual options, and parent involvement (Pearson, Inc., 2005).

Quite a few evaluation studies have been conducted on SuccessMaker. The Education Commission of the States (1999) had a large-scale research evalua-

tion conducted on the impact of SuccessMaker, which by and large did not show clear advantages of this program. The most emphasized aspects were that the program could not be a stand-alone intervention, but needed to be integrated within a traditional curriculum and other activities, and without this integration the program was not as effective. However, several evaluations have indicated that SuccessMaker can result in moderate gains in reading in schools. A number of school districts have shown better scores in reading, and Kulik's meta-analysis reported that SuccessMaker resulted in significantly better scores on standardized testing (Kulik, 1994). Miller, DeJean, and Miller (2000) observed that the embedded curricula in SuccessMaker did not complement existing curricula, instructional sequences, and teaching methods, but the teachers who were using the program thought that it was still a benefit to students because they were exposed to more content and strategies.

KnowledgeBox. KnowledgeBox is a K-6 lesson development tool. The program helps teachers customize existing lessons by combining engaging video, interactive software, Internet links, and electronic text resources into their curriculum. It also supports varied instructional approaches: direct instruction, small group, or independent work. The distinguishing feature is that teachers can choose pacing and target instruction for specific students and also collaborate and mentor, or be mentored by, other teachers (Pearson, Inc., 2005). However, we were unable to find any significant literature on the evaluation of KnowledgeBox.

NovaNet. NovaNet is a comprehensive software suite designed for grades 6-12. It includes an online courseware system that is integrated with assessment and student management tools. Students work at their own pace in completing the online course content and assessments. The student tracking and management tools then allow students to progress in meeting school standards. This suite allows individual students to either remediate or progress at a faster pace in completing course credits and preparing for state and other standardized tests.

Student Information Series. The Pearson Student Information Series includes three different products: SASI, Pearson Centerpoint, and CIMS student. SASI is a student management system that collects and manages student records, enrollments, scheduling, and attendance data. It includes such features as scheduling, parent collaboration, a grade book, and the creation of registration forms. Pearson Centerpoint is a Web-based student information communications tool. It handles student attendance and grade recording, while also supporting student and teacher calendars, automated alert emails to parents, student and class discussion boards, assessments construction, online assignment posting, reports generation, and announcements. CIMS Student maintains a great deal of student data, including home information, discipline records, emergency information, immunizations, course requests, and others. Student and academic information is automated by the system, which captures student grades and teacher comments and generates GPAs and class rankings in multiple formats that can be provided to students, parents, or other educational institutions. Likewise, CIMS tracks attendance and generates efficient attendance reports.

In summary, Table 3[4] shows the features that Pearson Digital Learning seems to offer, though again we advise that these ratings be interpreted with caution, and many features are a matter of degree rather than yes-no.

Table 3. Major features of Pearson Digital Learning

Features (grayed features support information-age needs)			Pearson
Instructional Method	Standard features	Content presentation	✓
		Curriculum standards	✓
		Direct instruction	✓
		Bilingual	✓
		Self-paced learning	✓
		Project-based work	✓
		Group work	✓
		Authentic, real-world problems	✓
		Individualized instruction	✓
	Teacher customiz-ability	Adaptive sequencing	✓
		Adaptive lesson plans	✓
		Customizable instructional content	✓
		Prescription of lessons	✓
	Outside school	Online message center	✓
		Online discussion board	✓
		Project-based work	✓
		Activities/homework with parent involvement	✓
		Community relations and support	✓
		Online lesson plan management for teachers	✓
Data management		Attendance	✓
		Health information	✓
		Parent/guardian information	✓
		Enrollment	✓
		Class schedule	✓
		Record of attainments mastered	✓
		Mastery progress	✓
Assessment		Post test / Pre test	✓
		Formative tests	✓
		Practice tests	✓
		Diagnostic tests	✓
		Mastery-level tests	✓
Reporting		Summative test report to teachers/ parents	✓
		Formative test report to teachers/ parents	✓
		Student information report to teachers/ parents	✓
		Record of attainments report to teachers/ parents	✓
		Mastery progress report to teachers/ parents	✓
		Customizable reporting for teachers	✓

Achievement Technologies, Inc.

Achievement Technologies is a company offering an LMS with over one million users (SkillsTutor, 2005). While their primary software product is SkillsTutor, a true LMS, they also offer a number of additional products for different grade levels, workplace training, and instructional content alone. These include K-2 Learning Milestones, SkillsBank, CornerStone, and a number of Workforce Education products,

SkillsTutor. SkillsTutor is an LMS for grades 2 to adult. It provides age-specific instruction in language arts, math, science, and workforce readiness skills. The product includes more than 1,000 activities, and each subject area contains 40 to 70 lessons that help students to learn major concepts and skills mostly needed in standardized tests (Felix, 2003). These lessons take around 20 minutes each to complete. Some of these lessons have components of higher-order thinking skills as well. The lessons begin with the introduction of concepts, and students are given opportunities to practice skills with explicit feedback. Pretests and post-tests, tracking student progress, and tests that are in a similar format to standardized tests are provided. Diagnostic tests are also provided in the program in order to identify each student's weak areas. This helps the system to provide the appropriate lessons to help all students reach the achievement level. As a whole, the management system essentially assesses students' skills, prescribes their lesson assignments, monitors the students' progress, reports results to teachers and parents, and generates accountability reports (SkillsTutor, Inc., 2005).

K-2 Learning Milestones. K-2 Learning Milestones is Achievement Technologies' product for lower grade levels. It includes pre-reading, phonics, and math skills for young students. Learning offers pre-instruction, diagnostic tests and customizable, printable workbook activities. It also offers customizable assessment tests that it grades automatically and a reporting utility for tracking achievement. Learning Milestones is also appropriate for supporting ESL students with audio instructions available in both English and Spanish.

SkillsBank. SkillsBank is a scaled-down offering of SkillsTutor. SkillsBank offers the instructional content of SkillsTutor without the additional features that SkillsTutor offers. Content is available both online and through CD-ROMs.

CornerStone. CornerStone focuses on strengthening students' key skills of language arts, reading vocabulary, reading comprehension, and math. CornerStone is designed to supplement the classroom instruction for grades 2-4, 3-4, 5-6, and 7-8. It offers interactive lessons, tutorials, and practice tests along with a management system for teachers that allows for individualized lesson plans. CornerStone also offers a reporting feature for tracking student achievement and practice worksheets for students to take home.

Workforce Education. Achievement Technologies also offers software to help adults or students about to enter the workforce. The Workforce Education suite is divided into the following components: employability and work maturity skills, work based learning, and citizenship skills.

In summary, Table 4[5] shows the features that Achievement Technologies seems to offer, though we again advise that these ratings be interpreted with caution, and many features are a matter of degree rather than yes-no.

Table 4. Major features of Achievement Technologies

Features (grayed features support information-age needs)			Achievement Technologies
Instructional Method	Standard features	Content presentation	✓
		Curriculum standards	✓
		Direct instruction	
		Bilingual	✓
		Self-paced learning	✓
		Project-based work	
		Group work	✓
		Authentic, real-world problems	✓
		Individualized instruction	✓
	Teacher customizability	Adaptive sequencing	✓
		Adaptive lesson plans	✓
		Customizable instructional content	✓
		Prescription of lessons	✓
	Outside school	Online message center	
		Online discussion board	
		Project-based work	
		Activities/homework with parent involvement	✓
		Community relations and support	
		Online lesson plan management for teachers	
Data management		Attendance	
		Health information	
		Parent/guardian information	
		Enrollment	
		Class schedule	
		Record of attainments mastered	✓
		Mastery progress	✓
Assessment		Post test / Pre test	✓
		Formative tests	
		Practice tests	
		Diagnostic tests	✓
		Mastery-level tests	✓
Reporting		Summative test report to teachers/parents	✓
		Formative test report to teachers/ parents	✓
		Student information report to teachers/ parents	
		Record of attainments report to teachers/ parents	✓
		Mastery progress report to teachers/ parents	✓
		Customizable reporting for teachers	

Compared to the larger LMSs, there were very few independent studies available that reviewed SkillsTutor or the other Achivement Technologies products. The Achievement Technologies studies that were primarily available were effectiveness reports on using SkillsTutor as an intervention tool for low and high achieving students. One independent study (Felix, 2003) was conducted in Jones Middle School in Marion, Indiana. The school used the online version of SkillsTutor as an intervention tool for students who did not pass the Indiana Statewide Testing for Educational Progress (ISTEP) test. The teacher there described the use of SkillsTutor as "a major contributor to overall improved academic performance" (p. 50) and "SkillsTutor helped cover the basics, and if the kids don't know the basics, they will never reach the higher level" (p. 50). The program was also being used as a homework program for accelerated students to practice for the ISTEP test at home. The school had tracked scores for the past three years, and the study showed considerable improvement in this student population. Overall, math scores were enhanced 40%, and scores for the Language Arts class improved 145% (Felix, 2003).

Co-nect

The Co-nect model was established in 1992 and has been working with schools to incorporate an individualized, systemic, whole-school reform effort that is focused on improving student performance through the restructuring of educational environments. The efforts are focused toward organizational restructuring, building community relations and support, and classroom-level changes. In classroom activities, Co-nect promotes a standards-based approach in project-based learning that is based on authentic "real-world" problems (Co-nect, Inc., 2005).

The overall structure of the Co-nect model is demonstrated in the five benchmarks adopted by the design team of Co-nect to produce high-quality teaching and learning. They are (1) shared accountability for results, (2) use of project-based learning for understanding and accomplishment, (3) comprehensive assessment and reporting for continuous improvement, (4) team-based and cluster-based school organization for continuous improvement, and (5) use of technology integration in the curriculum (Co-nect, Inc., 2005). In summary, Table 5[6] shows the features that Co-nect seems to offer, though again we advise that these ratings be interpreted with caution, and many features are a matter of degree rather than yes-no.

Ross and Lowther (2003) conducted a large-scale study in five inner-city schools relative to a matched comparison sample of four schools in the same district. The study examined five Co-nect schools in an inner-city school district on the aspects of (a) school climate, (b) teaching methods, (c) teacher buy-in, (d) level of design implementation, and (e) student achievement. Results of this study showed the following differences between Co-nect schools and similar schools. Co-nect's effects on instruction, particularly in the direction of suggesting active learning, were more apparent at the lower-SES than higher-SES schools. Co-nect engendered use of student-centered teaching strategies and use of technology as a learning tool, appeared to create a positive climate, and was well-received by teachers and principals. However Co-nect schools showed mixed results in raising achievement on district and state norms. Achievement outcomes were mixed, showing positive results relative to the state and district norms for three of the Co-nect schools but negative outcomes for two of the schools. Also, by the time the study was completed, Memphis City Schools announced that all of its 165 schools would be required to discontinue implementation of Co-nect (Ross & Lowther, 2003).

Table 5. Major features of Co-nect

Features (grayed features support information-age needs)			Co-nect
Instructional Method	Standard features	Content presentation	✓
		Curriculum standards	✓✓
		Direct instruction	
		Bilingual	✓
		Self-paced learning	✓
		Project-based work	✓
		Group work	✓
		Authentic, real-world problems	✓
		Individualized instruction	✓
	Teacher customizability	Adaptive sequencing	✓
		Adaptive lesson plans	✓
		Customizable instructional content	✓
		Prescription of lessons	✓
	Outside school	Online message center	
		Online discussion board	
		Project-based work	✓
		Activities/homework with parent involvement	✓
		Community relations and support	✓
		Online lesson plan management for teachers	
Data management		Attendance	
		Health information	
		Parent/guardian information	
		Enrollment	
		Class schedule	
		Record of attainments mastered	✓
		Mastery progress	✓
Assessment		Post test / Pre test	✓
		Formative tests	
		Practice tests	
		Diagnostic tests	✓
		Mastery-level tests	✓
Reporting		Summative test report to teachers/ parents	✓
		Formative test report to teachers/ parents	✓
		Student information report to teachers/ parents	
		Record of attainments report to teachers/ parents	✓
		Mastery progress report to teachers/ parents	✓
		Customizable reporting for teachers	

Others

Although these are some of the most representative LMSs, there are many others available, such as Sylvan Learning, Renaissance Learning, Riverdeep Learning, and American Education Corporation, among others. These LMSs should also be examined and evaluated in the near future to investigate what they can offer to K-12 classrooms. However, given the number of products on the market, it is beyond the scope of this chapter to examine them.

Potential for Information Age

This section has described several of the major LMS products available to K-12 schools in the United States. It is important to note that many of these products are the latest in a long history of products that were first developed many years ago, over 50 years in some cases. Furthermore, these companies have been in constant flux as they purchase and absorb competitors. This has sometimes resulted in a fragmented and confusing collection of products and features, and some of these features were developed to meet the needs of the sorting-focused model of education, rather than placing a true focus on learner-centered instruction. Furthermore, as can be seen in the description of these LMSs, many of them are composed of multiple products and therefore do not seamlessly blend together to create a true, systemic, LMS. However, these products will continue to evolve toward providing true, systemic, integrated, learner-centered services, and some of the features currently available are already well-suited for the information-age paradigm. Table 6[7] presents a summary and comparison of the various features that the reviewed LMSs offer and indicates which features are well-suited to information-age needs. Again, we advise that these ratings be interpreted with caution, and many features are a matter of degree rather than yes-no.

Current Trends in LMS

With a history in CAI and ILS, LMSs currently still incorporate much of the drill-and-practice approach that was designed to serve the needs of the industrial-age, time-based, sorting-focused, teacher-centered, standardized paradigm. Many ILSs focus on remedial learning and instruction of basic knowledge (Foshay, 1998; Sherry, 1993). LMSs are continuing to evolve and are slowly moving toward supporting various approaches of instruction, including a focus on customizable and personalized instruction and assessment (Sherry, 1993). Taylor (2004) identifies customizing assessments, analyzing student progress, evaluating student performance, tracking academic achievement, and identifying areas for additional scaffolding or assistance as some of the areas where technology can offer significant contributions to schools and classrooms, and these features are being integrated into LMSs. It is therefore important that LMSs continue to develop toward better serving the needs of the information-age paradigm, which will be attainment-based, learning-focused, learner-centered, and customized. LMSs also need to continue to teach more higher-level thinking skills and support a more student-directed, self-motivated learning process, which will help develop critical-thinking and problem-solving skills and encourage a life-long love of learning. LMSs should develop stronger support for appropriate methods to accomplish this, such as integrated, thematic, authentic problem-based learning.

Furthermore, the continued growth and availability of computers and computer networks is guiding LMSs toward a more network-based structure. The U.S. Department of Education announced that the number of computers in schools has been growing over the last 10 years, and 99% of American schools now have a 5:1 student to computer ratio (U.S. Department of Education, 2004). With the increasing numbers of computers and Internet connections available in classrooms, LMS is starting to play a more critical role in learning. Furthermore, with the increasing spread of wireless networking, LMSs will be able to leave the physical bounds of the classroom and better support learning outside of the school. Students will have their learning better supported at home and in the community as they interact with real problems and become more involved in service learning. Parents will find better support in working with their children and being involved in out-of-school learning activities. The collection of student learning artifacts in the form of student portfolios will also have a place in LMS.

LMSs and the continued research on reusable learning objects and their management are also putting pressure on LMSs to support the use of learning objects on multiple platforms of instructional software.

Table 6. Comparison of major features of LMS products

Features (grayed features support information-age needs)			PLATO	Pearson Digital Learning	Achievement Technologies	Co-nect
Instructional Method	Standard features	Content presentation	✓	✓	✓	✓
		Curriculum standards	✓	✓	✓	✓
		Direct instruction		✓		
		Bilingual	✓	✓	✓	✓
		Self-paced learning	✓	✓	✓	✓
		Project-based work		✓		✓
		Group work			✓	✓
		Authentic, real-world problems		✓	✓	✓
		Individualized instruction	✓	✓	✓	✓
	Teacher customiz-ability	Adaptive sequencing	✓	✓	✓	✓
		Adaptive lesson plans		✓	✓	✓
		Customizable instructional content		✓	✓	✓
		Prescription of lessons	✓	✓	✓	✓
	Outside school	Online message center		✓		
		Online discussion board		✓		
		Project-based work		✓		✓
		Activities/homework with parent involvement	✓	✓	✓	✓
		Community relations and support	✓	✓		✓
		Online lesson plan management for teachers		✓		
Data management		Attendance		✓		
		Health information		✓		
		Parent/guardian information		✓		
		Enrollment		✓		
		Class schedule		✓		
		Record of attainments mastered	✓	✓	✓	✓
		Mastery progress	✓	✓	✓	✓
Assessment		Post test / Pre test	✓	✓	✓	✓
		Formative tests		✓		
		Practice tests	✓	✓		
		Diagnostic tests	✓	✓	✓	✓
		Mastery-level tests	✓	✓	✓	✓
Reporting		Summative test report to teachers/ parents	✓	✓	✓	✓
		Formative test report to teachers/ parents	✓	✓	✓	✓
		Student information report to teachers/ parents		✓		
		Record of attainments report to teachers/ parents	✓	✓	✓	✓
		Mastery progress report to teachers/ parents	✓	✓	✓	✓
		Customizable reporting for teachers		✓		

Reflections and Recommendations for Future LMS and Research

While the LMS examples discussed in this paper illustrate the continued growth of computer technology toward systemic, customizable, and adaptive interchangeable packages, the literature on the evaluation of LMSs clearly points out that improvements are needed. The results of the studies discussed indicate that LMSs assist learning more than traditional instruction alone. It is important that more design-based research (Brown, 1992; Collins, 1992) and formative research (Reigeluth & Frick, 1999) be conducted to identify specific aspects of LMSs that do and do not work well and, more importantly, to identify ways they can be improved.

It is clear that much work remains to be done before LMSs fully answer the needs of the information-age learner. Whether these LMSs continue to develop or new, alternative LMSs appear, this process will require much research work on LMSs. The following ideas detail what the LMS of the near future needs to support, and also what kind of research is needed for the improved design of LMSs in the future.

- Providing more constructivist-based instruction that focuses on personalized and flexible approaches to meet learner-defined goals in the future (Reigeluth & Garfinkle, 1994).
- Supporting collaborative and cooperative learning inside and outside of the classroom and providing students with a seamless learning environment between school and *home*, allowing *parents* to be more engaged in their child's learning (Taylor, 2004).
- Addressing personalized assessment, progress tracking, reporting, and responsiveness to learner needs in the future (Reigeluth & Garfinkle, 1994).
- Truly integrating systems that allow for improved collaboration across systems and among stakeholders (Sherry, 1993).
- Improving support for professional diagnosis and development for teachers and other stakeholders.
- Improving cost effectiveness and maximizing efficiency in leveraging existing resources that are already available in schools and LMSs (Szabo & Flesher, 2002).

These are some of the current trends and issues of LMSs, and they should be examined and evaluated through more in-depth research.

Summary

In summary, a learning management system (LMS) is a computer system that incorporates providing instruction, tracking achievement, and managing resources for individual students and an organization as a whole. This paper focused on the examination of previous research studies on LMS by discussing the need for integrated computer systems in the schools, providing an overview of past terminology used to describe the use of computers for instruction and how LMS relates to these terms, presenting an analysis and comparison of four current LMSs for K-12 schools, reviewing evaluation studies on those LMSs, and concluding with a reflection on LMS trends and issues.

References

Advanced Distributed Learning. (2003). *Advanced distributed learning* [Homepage of Advanced Distributed Learning]. Retrieved March 13, 2005, from http://adlnet.org/

Alexander, S. (2001). Learning curve. *InfoWorld, 23*(23), 59-61.

Bailey, G. D. (1993). Wanted: A road map for understanding integrated learning systems. In G. D. Bailey (Ed.), *Computer-based integrated learning systems* (pp. 3-9). Englewood Cliffs, NJ: Educational Technology Publications.

Becker, H. J. (1993). A model for improving the performance of integrated learning systems. In G. D. Bailey (Ed.), *Computer-based integrated learning systems* (pp. 11-31). Englewood Cliffs, NJ: Educational Technology Publications.

Bracey, G. W. (1993). The bright future of integrated learning systems. In G. D. Bailey (Ed.), *Computer-based integrated learning systems*. Englewood Cliffs, NJ: Educational Technology Publications.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of Learning Sciences, 2*(2), 141-178.

Brush, T. A., Armstrong, J., Barbrow, D., & Ulintz, L. (1999). Design and delivery of integrated learning systems: Their impact on students achievement and attitudes. *Educational Computing Research, 21*(4), 475-486.

Collins, A. (Ed.). (1992). *Toward a design science of education*. New York: Springer-Verlag.

Co-nect, Inc. (2005, May 2). *Our approach: Data-driven solutions to improve instruction.* Retrieved May, 2, 2005, from http://plato.com/products_all.asp

Connolly, P. J. (2001). A standard for success. *InfoWorld, 23*(42), 57-58.

Deubel, P. (2002). Selecting curriculum-based software. *Learning & Leading with Technology, 29*(5), 10-16.

Dunkel, P. A. (1999). Considerations in developing and using computer-adaptive tests to assess second language proficiency. *Language Learning & Technology, 2*(2), 77-93.

EDUCAUSE Evolving Technologies Committee. (2003). *Course management systems (CMS)*. Retrieved April 25, 2005, from http://www.educause.edu/ir/library/pdf/DEC0302.pdf

Felix, K. (2003). In the spotlight. *MultiMedia Schools, 10*(6), 49-50.

Foshay, R. (1998). *Instructional philosophy and strategic direction of the PLATO system.* Technical paper. Bloomington, MN: PLATO Learning, Inc.

Foshay, R. (2002). *An overview of the research base of PLATO.* Bloomington, MN: PLATO Learning, Inc.

Friesen, N., Roberts, A., & Fisher, S. (2002). Metadata for learning objects. *Canadian Journal of Learning and Technology* (Online version), *28*(3), 43-53. Retrieved July 10, 2005, from http://www.cjlt.ca/content/vol28.3/friesen_etal.html

Getting up to speed on learning management systems. (2002). Retrieved April 3, 2005, from http://www.brandonhall.com/public/execsums/execsum_gutsonlmss.pdf

Gibbons, A. S., Nelson, J. M., & Richards, R. (2002). The nature and origin of instructional objects. In D. A. Wiley (Ed.), *The instructional use of learning objects: Online version*. Retrieved March 13, 2005, from http://reusability.org/read/chapters/gibbons.doc

Gilhooly, K. (2001). Making e-learning effective. *Computerworld, 35*(29), 52-53.

Hodgins, H. W. (2002). The future of learning objects. In D. A. Wiley (Ed.), *The instructional use of learning objects: Online version*. Retrieved March 13, 2005, http://reusability.org/read/chapters/hodgins.doc

Joseph, R., & Reigeluth, C. M. (2002, July-August). Beyond technology integration: The case for technology transformation. *Educational Technology, 42,* 9-12.

Kulik, J. A. (2003). *Instructional technology and school reform models.* Ann Arbor: Office of Evaluations & Examinations, University of Michigan. Retrieved March 10, 2005, from http://www.schooldata.com/mdrtechhilites.asp

Leslie, S. (2003). *Important characteristics of course management systems: Findings from the Edutools.info project.* Retrieved April 15, 2005, from http://www.edtechpost.ca/gems/cms_characteristics.htm

McCombs, B., & Whisler, J. (1997). *The learner-centered classroom and school.* San Francisco: Jossey-Bass.

MERLOT. (2005). *Multimedia educational resource for learning and on-line teaching Web site.* Retrieved March 13, 2005, from http://www.merlot.org/

Merrill, M. D. (2002). Knowledge objects to support inquiry-based, online learning. In D. A. Wiley (Ed.), *The instructional use of learning objects: Online version.* Retrieved March 13, 2005, from http://reusability.org/read/chapters/merrill.doc

Miller, L., DeJean, J., & Miller, R. (2000). The literacy curriculum and use of an Integrated Learning System. *Journal of Research in Reading, 23*(2), 123-135.

Oakes, K. (2002). E-learning: LCMS, LMS—They're not just acronyms but powerful systems for learning. *T+D, 56*(3), 73-75.

Pack, T. (2002). Corporate learning gets digital. *EContent, 25*(7), 22-27.

Parr, J. M., & Fung, I. (2001, September 28, 2004). *A review of the literature on computer-assisted learning, particularly integrated learning systems, and outcomes with respect to literacy and numeracy.* Retrieved April 2, 2005, from http://www.minedu.govt.nz/index.cfm?layout=document&documentid=5499&indexid=6920&indexparentid=1024

Parrish, P. E. (2004). The trouble with learning objects. *Educational Technology Research & Development, 52*(1), 49-57.

Pearson, Inc. (2005, May 2). *Pearson Digital Learning: All products and services.* Retrieved May, 2, 2005, from http://www.pearsondigital.com/products/

PLATO, Inc. (2005, May 2). *Products and services: All products and services.* Retrieved May, 2, 2005, from http://plato.com/products_all.asp

Reigeluth, C. M. (1994). The imperative for systemic change. In C. M. Reigeluth, & R. J. Garfinkle (Eds.), *Systemic change in education* (pp. 3-12). Englewood Cliffs, NJ: Educational Technology Publications.

Reigeluth, C. M. (1997, November). Educational standards: To standardize or to customize learning? *Phi Delta Kappan, 79*(3), 202-206.

Reigeluth, C. M., & Frick, T. W. (1999). Formative research: A methodology for creating and improving design theories. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (Vol. 2, pp.633-651). Mahwah, NJ: Laurence Erlbaum Assocates, Publishers.

Reigeluth, C. M., & Garfinkle, R. J. (1994). Envisioning a new system of education. In C. M. Reigeluth & R. J. Garfinkle (Eds.), *Systemic change in education* (pp. 59-70). Englewood Cliffs, NJ: Educational Technology Publications.

Reiser, R. A. (1987). Instructional technology: A history. In R. M. Gagne (Ed.), *Instructional technology: Foundations* (pp. 11-48). Hillsdale, NJ: Lawrence Erlbaum Associates.

Ross, S. M., & Lowther, D. L. (2003). Impacts of the Co-nect school reform design on classroom instruction, school climate, and student achievement in inner-city schools. *Journal of Education for Students Placed at Risk, 8*(2), 215-246.

Schlechty, P. C. (1991). *Schools for the 21st century: Leadership imperatives for educational reform.* San Francisco: Jossey-Bass Inc.

Senge, P., Cambron-McCabe, N., Lucas, T., Smith, B., Dutton, J., & Kleiner, A. (2000). *Schools that learn: A fifth discipline fieldbook for educators, parents, and everyone who cares about education.* Toronto, Canada: Currency.

Sherry, M. (1993). Integrated Learning Systems: What may we expect in the future? In G. D. Bailey (Ed.), *Computer-based Integrated Learning Systems* (pp. 137-141). Englewood Cliffs, NJ: Educational Technology Publications.

Shore, A., & Johnson, M. F. (1993). Integrated Learning Systems: A vision for the future. In G. D. Bailey (Ed.), *Computer-based Integrated Learning Systems* (pp. 83-91). Englewood Cliffs, NJ: Educational Technology Publications.

SkillsTutor, Inc. (2005, May 2). *Why choose products developed by achievement technologies?: Instructional, supplemental, practical and effective.* Retrieved May, 2, 2005, from http://skillstutor.com/index.cfm?fuseaction=products.home

Successmaker. (1999). Educational Resources Information Center (ERIC ED447436). Retrieved April 28, 2006, from http://www.eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/23/c1/41.pdf

Szabo, M., & Flesher, K. (2002). *CMI theory and practice: Historical roots of learning management systems.* Paper presented at the E-Learn World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education, Montreal, Canada.

Taylor, F. P. (2004). Education technology helps unite school communities, improve academic achievement. *T.H.E. Journal, 31*(10), 46-48.

Toffler, A. (1984). *The third wave.* New York: Bantam.

U.S. Department of Education, O. o. E. T. (2004). *Toward a new golden age in American education: How the Internet, the law and today's students are revolutionizing expectations.* Washington, DC: U.S. Department of Education, Office of Educational Technology.

Van Dusen, L. M., & Worthen, B. R. (1994). The impact of Integrated Learning System implementation on student outcomes: Implications for research and evaluation. *International Journal of Educational Research, 21,* 13-24.

Waterford early reading program. (1999). Educational Resources Information Center (ERIC ED447438). Retrieve April 18, 2006, from http://www.eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/23/c1/86.pdf

Wiley, D. A. (2002). Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. In D. A. Wiley (Ed.), *The instructional use of learning objects: Online version.* Retrieved March 13, 2005, from http://reusability.org/read/chapters/wiley.doc

Endnotes

1 An online database of individual reviews of different CMSs by the Western Cooperative on Educational Telecommunications (WCET).

2 Web page without page number.

3 PLATO Learning, Inc. was contacted to review the features attributed to them for accuracy but declined comment.

4 Pearson Digital Learning was contacted to review the features attributed to them for accuracy.

5 Achievement Technologies was contacted to review the features attributed to them for accuracy.

6 Co-nect was contacted to review the features attributed to them for accuracy.

7 The authors would like to acknowledge the contribution of Dr. Tom Brush at Indiana University for his support in reviewing and providing advice on the development of this table of features.

Chapter V

Integrating Computer-Supported Learning into Traditional Distance Courses

Cengiz Hakan Aydin, Anadolu University, Turkey

Mehmet Emin Mutlu, Open Education Faculty, Turkey

Marina S. McIsaac,
Educational Media & Arizona State University, USA

Abstract

This chapter describes how a traditional distance education provider, Anadolu University of Turkey, integrated computer-supported learning into its traditional distance courses. Anadolu University has been struggling with offering quality education to their large body of distance learners (approximately 1 million). To do so, the university tries to integrate computer-supported learning environments into its traditional correspondence programs. Building supplementary e-learning portals, through which learners can access videos, textbooks, audio books, computer-assisted instruction materials, self-tests, pedagogical and managerial support is one of the important steps taken. The authors hope