Roles for Technology in the Information-Age Paradigm of Education: Learning Management Systems

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This article presents a detailed description of the powerful and necessary role which technology can play in the information-age paradigm of education described in the four articles comprising this series. This article calls for a learning management system (LMS), a comprehensive and integrated application of technology to the learning process, which will provide four primary roles for student learning: recordkeeping, planning, instruction, and assessment. Each of these four major roles is described in terms of the functions it needs in order to support student learning. Finally, secondary roles such as communication and general data administration are described in order to illustrate the systemic nature of LMS technology necessary to fully support the learner-centered approach needed in the information-age paradigm of education.

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Paradigm Change in Public Education

This is the fourth in a series of four articles on paradigm change in education. The first addressed the need for paradigm change in education and described the AECT FutureMinds Initiative for helping state departments of education to engage their school districts in this kind of change. The second described the School System Transformation (SST) Protocol, which captures the current knowledge about how states can help their school districts to engage in paradigm change. The third described the nature of the learner-centered paradigm of education, and it addressed why this paradigm is needed. This fourth article explores a full range of roles that technology might play in this new paradigm of education.

Introduction

The previous article in this series (S. L. Watson & Reigeluth, 2008) discussed the need for changing the paradigm of education from the sorting-focused, industrial-age, factory model of schools to the learning-focused, information-age, customized paradigm. It also presented one possible vision of this new paradigm, based on several important bodies of research. It closed by saying that powerful technological tools would be necessary for this new paradigm to succeed in providing a quantum improvement in student learning. This article offers suggestions for some of the main roles or functions that such tools might need to fulfill.

We currently see four major roles and four secondary roles, all of which should be seamlessly integrated into a single system. While the term, learning management system (LMS), has been used with several different meanings, it comes closest to capturing the meaning of such a comprehensive, integrated tool for the information-age paradigm of education (W. R. Watson, S. K. Lee, & C. M. Reigeluth, 2007). The major roles for such an LMS include *recordkeeping for student learning, planning for student learning, instruction for student learning, and assessment for (and of) student learning*. The secondary roles include *communication, general student data, school personnel information, and LMS administration*. Each of these is discussed next.

Major Roles for Information-Age Learning Management Systems

1. Recordkeeping for Student Learning

The new paradigm of education requires the student, teacher, and parents to be informed of what the student has actually learned at any point in time, to assure that progress is continuous and personalized, and to make good decisions about what to learn next. The

recordkeeping tool of an information-age LMS will replace the current report card. The report card in general use serves to compare one student with another and tells you little to nothing about what a student has actually learned. In contrast, this tool will provide systematic and comprehensive information about what each student has learned. We imagine that this tool will have three components: (1) a general record of what can be learned, including required educational standards set at national, state, and local levels, and optional educational standards; (2) a personal record of what has been learned by each student; and (3) a personal record of student characteristics that influence learning for each student. Each of these is discussed next.

1.1 Standards inventory. The purpose of this general record is to inform the planning process (see role #2 below) by providing information about the required standards set at national, state, and local levels and information about additional standards that cultivate the student's particular interests and talents. This information will provide the student, teacher, and parents with a vision as to what should be and could be achieved. Furthermore, the standards will be organized into maps for each domain of learning based on Domain Theory (Bunderson, Wiley, & McBride, in press). Each domain map will include (a) major attainments with boundaries showing the easiest and hardest version of each attainment, (b) categories of attainments, where each category represents a pathway for learning, and (c) a difficulty-based sequence of attainments along each pathway. For each attainment in the map, there will be an indication as to whether or not it is a required standard, and if so, what level of difficulty is required. In essence, the Standards Inventory will present a list of things that should or can be learned, along with levels, standards, and/or criteria at which they should or could be learned.

1.2 Personal attainments inventory. The purpose of this personal record is also to inform the planning process (role #2), only it will do so by keeping track of each student's progress in meeting the required and optional standards, and therefore what is within reach for the student to learn next. It will serve as a customized mastery progress report to the student, teacher, and parents. In this tool, attainments will be checked off as they are reached, and if any are not listed in the Standards Inventory, they can be added to the Personal Attainments Inventory. Each attainment will be documented and reported by date attained, and the record will identify any required standards (in the Standards Inventory) that are overdue and which ones are due next in each domain. Each attainment will also be linked to evidence of its accomplishment, ranging from original artifacts with a formal evaluation, to summary data from a simulation-based performance test. Given this information, the student will be able to easily generate different kinds of portfolios for different purposes by pulling out selected attainments and artifacts. All the information recorded, including the attainments and evidence, will have flexibly controlled access to protect the learner's privacy.

1.3 Personal characteristics inventory. This personal record is intended to inform both the planning process (role #2) and the instructional process (role #3). It will keep track of each student's characteristics that influence learning, such as learning styles, profile of multiple intelligences, student interests, major life events, and so forth. These data will be convenient to refer to when major decisions about learning objectives and goals are to be made for the student and will be especially useful for teachers who are not familiar with the student. They will help teachers to customize each student's learning plan to best suit his or her interests, learning styles, life experiences, and educational background. But the Personal Characteristics Inventory will also be an effective tool to customize the instruction itself. The student data will be fed into computer-based tutorials, simulations, and other computer-based learning tools to automatically tailor appropriate parameters of the instruction for each student. And the teachers will refer to these data to improve the way they coach and advise the student during projects and other instructional events.

Clearly, a customized paradigm of education requires keeping a lot of records. Technology can tremendously alleviate the time, drudgery, and expense of maintaining and accessing those records. The recordkeeping tool will provide systematic and comprehensive information for customizing the learning process, including an inventory of what is to be learned, an inventory of what the student has learned, and an inventory of the student's characteristics that influence instruction. It will facilitate collaborative efforts among students, parents, teachers, the community, the state, and the nation to assure that appropriate standards are being met while customized attainments are achieved by each student. And it will facilitate customizing the instruction to each student's individual needs.

2. Planning for Student Learning

In the previous issue of this magazine, S. L. Watson and Reigeluth (2008) described a contract for a personal learning plan (PLP) as an important feature of the new paradigm of education. Assisting with development of that contract is the second major role for an information-age LMS. This planning will usually be done in a face-to-face meeting between the student, his or her mentor-teacher, and the student's parent(s) or guardian(s), while using the planning tool.

This planning tool will have many functions. It will help the student, parents, and teacher to (1) decide on *long-term goals*; (2) identify the full range of attainments *(current options)* that are presently within reach for the

student that could help meet those long-term goals; (3) select from those options the attainments that they want to pursue now *(short-term goals)*, based on requirements, long-term goals, interests, opportunities, etc.; (4) identify *projects* (or other means) for attaining the short-term goals; (5) identify *other students (teams)* who are interested in doing the same projects (if desired); (6) specify the *roles* that the teacher, parent, and any others might play in supporting the student in learning from the project; and (7) develop *contracts* that specify goals, projects, teams, roles, deadlines, and milestones. Each of these is discussed next.

2.1 Long-term goals. Many students graduate from college not knowing what they want to do with their lives. We propose that students should be encouraged to think about life goals (not just career goals) from an early age and be encouraged to be constantly on the lookout for better goals. A study by Harackiewicz, Barron, Tauer, Carter, and Elliott (2000) found that setting achievement goals has a positive effect on how "students approach, experience, and perform in class." Setting of goals—a means to building self-efficacy—proves to be a highly effective method for encouraging self-regulated learning (Schunk, 1990, 1991; Zimmerman, 1990). Long-term goals can help students pick motivating topics to study and give instrumental value for much of what they study. Therefore, the planning tool will help a student, teacher, and parents to develop and revise, in a collaborative fashion, the student's long-term goals. It will include access to motivating, informational, interactive multimedia programs about different careers and ways of life.

2.2 Current options. Another important function in educational planning is to know what attainments are within reach, given what the student has already learned. The planning tool, therefore, will access the student's Personal Attainment Inventory and compare it to the general Standards Inventory to automatically identify the full range of attainments that are current options for the student. This will be the student's world of possibilities for her or his next PLP.

2.3 Short-term goals. The student's PLP will specify what learning goals the student will accomplish during the next contract period (variable, but typically about two months, shorter for younger students). Thus, the planning tool will help the student, teacher, and parents to select from the current options the attainments to pursue now, based on requirements, long-term goals, interests, opportunities, and so forth. These goals typically will come from many different competency or subject areas. This is a crucial function of the planning tool because it will set the goals for the next learning contract, or PLP.

2.4 Projects. Having identified the ends for the PLP, the next step will be to identify the means, so this is another function for the planning tool. Typically, projects will be used as the means, but other options will sometimes be available (e.g., readings with discussions, or tutorials). The tool will help the student, teacher, and parents to identify projects or other means available in the school or community or online that will enable the student to attain the short-term goals. This tool will identify, say, a dozen projects rank ordered by the number of short-term goals (attainments) that each addresses. The student will then select the projects that are most related to their interests and long-term goals and cover all the short-term goals. Depending on the scope of each project, a student will undertake from one to about five projects during a single contract period. Finally, this tool will also have a feature that allows teachers and community people—and students—to post projects that they have developed or are sponsoring.

2.5 Teams. "The unfolding of the self always grows out of interaction with each other" (Ranson, Martin, Nixon, & McKeown, 1996, p. 14). Collaborative learning is a powerful form of learning (Gokhale, 1995). Thus, in most cases, students will work together in small teams on their projects. This means that another important function for the planning tool is to identify other students who are interested in working on the same project at the same time. Friends will sometimes choose projects so that they can work together, but teachers will only allow so much of that and will also require their students to work with students they don't know, seeking to create teams that are highly diverse (age, race, gender, socio-economic status). The planning tool will also use personality inventories (e.g., Myers-Briggs) to help students understand why their teammates may behave quite differently and how to deal with that.

2.6 Roles. In addition to collaborating with peers, students will receive support from their teacher, their parents, and perhaps various others (like community members or task experts). Therefore, another function for the planning tool is to help the teacher and the parents to define what they will do to support the student's learning on each project. Roles of the students and others who are not present in the planning meeting between the student, teacher, and parents will be determined with help from the contract-planning tool.

2.7 Contracts. The final step of the planning process will be to create the contract that contains the PLP. Reigeluth and Garfinkle (1994) identify learning contracts as a written agreement that "will serve a planning and monitoring function" (p. 64). A learning contract will essentially be an agreement between a student, teacher, and parents that specifies the goals that the student wishes to achieve, the means (primarily projects) that will be used to achieve them, the teacher's and parents' roles in supporting the student, and the deadline for completing each project (negotiated with the teammates for each project). Parents, teachers, and students, as Reigeluth and Garfinkle note, will meet once every two months or so, to review the results of the previous contract and plan a

new contract for the next period. Typically there will be a separate contract for each project during the period.

Clearly, the planning tool will be crucial to the instructional process in an information-age educational system. It would likely be impossible to customize the learning experience for each student without it. It will specify what the student, teacher, and parents will do, and it will be instrumental for monitoring the student's progress. In addition, Reigeluth and Garfinkle (1994) point out that "only through this kind of collaborative teaching approach will we overcome many obstacles to learning in some home environments" (p. 64), as this activity will forces reluctant parents to partake in the educational development of their children.

3. Instruction for Student Learning

Once a contract has been developed and signed, the projects need to be conducted. This is when instruction, broadly defined as "anything that is done purposely to facilitate learning" (Reigeluth & Carr-Chellman, in press), takes place. To implement the kind of learner-centered instruction described by Watson and Reigeluth in the previous issue of this magazine, the teacher will not be able to do all the teaching. The teacher's role will change to selecting or designing instructional tools for students to use and coaching students during their use of those tools. So what functions need to be performed in this third major role for an information-age LMS? We see four major functions: (1) project initiation, (2) instruction, (3) project support, and (4) instructional development. Combined, these four functions will ensure that an LMS truly supports learner-centered instruction in the information-age paradigm of education.

3.1 Project initiation. The project initiation tool will help the teacher and students to get started on each project. Depending on the age of the students, this tool will be used by the student, teacher, or both. The primary functions it serves will be to introduce the students to the project or problem to be solved (its goals and initial conditions), and help them get organized. They will already know a little about the project from the planning tool, and they will have already set a deadline for completing the project with their teammates. This Project Initiation tool will provide access to more information about the project (or problem) and will help the teammates identify tasks to perform, how they will work together on each task (collaboratively on the same tasks, or cooperatively on different tasks), the resources they will need, and milestones for different tasks during the project (time management). This information about the project will often be provided in a multimedia simulation, such as Bransford's STAR LEGACY (see Schwartz, Lin, Brophy, & Bransford, 1999).

3.2 Instruction. Once the students get organized for a project, they will begin working on it. As they work on it, they will encounter (identify) attainments they need in order to be successful. These will include such attainments or components of an attainment as: information that needs to be memorized, understandings that need to be acquired, skills that need to be developed, and various kinds of affective development. Some of these attainments and components will be developed by leaving the "project space" (which often occurs in a computer-based simulation) and entering the "instructional space" comprised of customizable learning objects of various kinds (Gibbons, Nelson, & Richards, 2002; Hodgins, 2002; Wiley, 2002), including mini-simulations, tutorials, WebQuests, and drill-and-practice (some in the form of educational games), that allow full development of an individual attainment or component, complete with its "automatization" (Anderson, 1983; Salisbury, 1990), if appropriate for mastery of it. Some attainments and components will also be acquired by using research (information-access) tools on the LMS. But not all such attainments and components will be developed in the LMS. Others will be developed by using off-line resources, doing off-line activities, and/or working with other people in the school or community (including teachers and parents), but those resources will be located primarily through the LMS. Once those attainments and/or components have been mastered, the student will reenter the project space and continue work on the project, cooperating or collaborating with teammates, as appropriate. Debriefing and reflection on the project activities at the end of the project—and periodically during the project—will also be important to the learning process and will be facilitated by the instructional tool.

3.3 Project support. This function of the instructional tool has two purposes: helping the students to manage the project and helping the teacher and parents to monitor and support the students' work on the project. Students will review project planning materials and check off project milestones and goals as they are completed. The system will alert teachers and parents to student progress on the project, such as notifying teachers of the submission of project deliverables or the completion of project milestones, in order to encourage and guide the student's progress, make recommendations, and facilitate the completion of the project. The teacher will also suggest resources or provide comments on submitted project deliverables to guide the student while he or she continues to work on the project.

3.4 Instructional development. The final function for the instructional tool is to support teachers, staff, parents, and even students in the development of new instruction—projects, learning objects, and other instructional tools. The LMS will contain a large repository of instructional tools that provide varied approaches to instruction. However, it seems that there will never be enough powerful instruction for all learners in all contexts. Therefore, an important feature

for an LMS will be to support the development of new instructional tools, which will often serve as learning objects, and will then be added to the repository and evaluated for effectiveness (see next section), ensuring that instruction continually improves. A powerful authoring system will support the creation of these new instructional tools by providing instructional guidance and even automatic development and programming of the instruction, similar to Merrill's (Merrill & ID2 Research Group, 1998) ID Expert. User-created content is an everyday reality in today's information age, with popular video games including toolkits to allow players to create their own versions of games, and Internet users developing their own content in the form of wikis and blogs, as well as videos and podcasts which they upload to share with others and continue the cycle of development and modification (Brown & Adler, 2008). This instructional development tool will provide similar support in customizing and creating customized instruction and projects. Furthermore, the easy and efficient application of learning object standards to created instruction will be a necessity in order to better share learning objects and evaluate their suitability and interoperability for different platforms (Connolly, 2001).

This section has highlighted the instructional functions that an LMS should provide. These include (a) introducing the project to a learner (or small team), (b) providing instructional tools (simulations, tutorials, drill and practice, WebQuests, research tools, communication tools, and learning objects) to support learning during the project, (c) providing tools for monitoring and supporting student progress on the project, and (d) providing tools to help teachers and others develop new projects and instructional tools.. The next section will discuss features that support the fourth major role of an information-age LMS: assessment for (and of) student learning.

4. Assessment for (and of) Student Learning

The assessment tool will be integrated with the instructional tool, so that teaching and testing will be fully integrated (Mitchell, 1992; Wiggins, 1998). To accomplish this, we envision the assessment tool fulfilling six functions: (1) presenting authentic tasks for student assessment, (2) evaluating student performances on those tasks, (3) providing immediate feedback to the student on the performances, (4) assessing whether or not an attainment has been reached (certification), (5) developing student assessments, and (6) improving instruction and assessment.

4.1 Presenting authentic tasks. The same authentic tasks that are used during instruction will be used for student assessment. The project itself will be an authentic task. And so will the instances (or cases) used in the "instructional space," where much of the learning occurs. Those instances, however, will not be restricted to the project that motivates the learner to master the attainments. To truly master an attainment, the learner must be able to use it in the full variety of situations for which it is appropriate. Those authentic situations will be used as the instances for the demonstrations (or examples) and applications (practice) of the attainment. There will be a large pool of authentic instances to draw from, that will include all the types of instances. And the learner will continue to do the applications until an established criterion is met across all the desired types of instances. In this manner, the applications will serve a dual role of instruction and assessment (both formative and summative). Simulations will often be used to enhance authenticity. Authenticity of applications will enhance transfer to real situations in which the attainments are needed. Authenticity will also help students understand why they are learning a particular attainment, and how it could be useful to them. This will help students become or stay motivated to learn (Frederickson & Collins, 1989).

4.2 Evaluating student performances. Whether in a simulation or a tutorial or drill and practice, the assessment tool will be designed to evaluate whether or not the criterion was met on each performance of the authentic task on the LMS. If the performance is not done on the LMS, then a teacher or other trained observer (who could even be a more advanced student) will have a handheld computer with a rubric for evaluating success on each criterion, and that information will be uploaded into the LMS.

4.3 Providing immediate feedback. Research has shown that frequency of *formative assessments* is positively related to student achievement (see, e.g., Marzano, 2006). Thus, based on the evaluation of student performance, the learner will be provided immediate feedback of either a confirmatory or corrective nature. This immediate feedback will often even be given during the performance for the greatest effect on learning, in which case it will be similar to coaching, scaffolding, or guiding the learner's performance, or it could be given at the end of the performance.

4.4 Certification. When the criterion for successful performance has been met on x out of the last y unassisted performances, the *summative assessment* will be complete and the corresponding attainment will be automatically checked off in the student's personal inventory of attainments, and a link will be provided to the evidence for that attainment (e.g., in the form of test results or artifacts produced). However, in cases where feedback is given during a performance, successful performance will not count toward the criterion. To count, the student's performance must be unassisted.

4.5 Developing student assessments. The assessment tool will also serve the function of supporting teachers and others in the development of formative and summative assessments for new instruction. Due to the integration of instruction and assessment in the LMS,

the test development tools will also be integrated with the instructional development tools, which will deal with feedback. For certification, the major function will be to help the developer identify the criterion for attainment and develop any necessary rubrics, so the tool will tap into information in the standards inventory described earlier and will help the test developer link them to the standards.

4.6 Improving instruction and assessment. The final function of the assessment tool will be to formatively assess the instruction and assessments in the LMS. It will do so by automatically identifying areas in which students are having difficulties, and it will even have diagnostic tools that offer a menu of suggestions for overcoming those problems. Those diagnostic tools will include proven principles of instruction, such as those represented by Merrill's (in press) "First Principles of Instruction."

Integration of the Four Roles

Note that these four roles will be seamlessly integrated. The recordkeeping tool will provide information automatically for the planning tool. The planning tool will identify instructional tools that are available. The assessment tool will be integrated into the instructional tool. And the assessment tool will feed information automatically into the recordkeeping tool. Also, there will be other roles or functions for an information-age LMS. These secondary roles are described next.

5. Secondary Roles

The final set of roles necessary for an ideal learning management system will encompass secondary roles, or functions, which are not necessarily directly related to student learning; although some, such as communication functions, can be used for learning. These functions are organized into the following four kinds: (1) communication, (2) general student data, (3) school personnel information, and (4) LMS administration. While these functions will not always directly deal with student learning, they will nevertheless be necessary functions for the LMS to be truly systemic in nature and provide the functionality needed to manage the entire learning process for a school or school district.

5.1 Communication. Communication functions are essential in supporting a learner-centered environment, as they allow teachers to communicate and collaborate with other teachers and staff, with their students, with their students' parents, and with members of the community and other stakeholders in the learning process. Students will communicate and collaborate with each other and will contact their teachers for help outside of the classroom, and parents will check on their children's progress and be more involved in their learning. Being able to communicate remotely via Internet technologies will allow education to extend beyond the walls of the classroom. Therefore, an information-age LMS will support Web communication technologies such as these. Furthermore, Web 2.0 technologies that allow for user-created content have become increasingly popular, and the Web has become a participatory social space to such a degree that *Time Magazine* named their person of the year for 2007 as "You" (Grossman, 2006). Furthermore, these Web 2.0 technologies such as wikis, blogs, and podcasts, and video sharing sites such as YouTube have helped to increase the participatory nature of learning (Brown & Adler, 2008). Additionally, LMS support for such additional Internet technologies as Webpage creation, discussion boards, and whiteboards will provide valuable tools for collaboration and communication. The inclusion of RSS feed support (P. Duffy & Bruns, 2006), which allows users to subscribe to favorite Websites and be notified of updated content, will put further power for communicating and organizing information into the hands of all users and stakeholders. While the use of these Web technologies will not always be applied directly to the learning process, more and more researchers are discussing the application of wikis (Augar, Raiman, & Zhou, 2004; P. Duffy & Bruns, 2006; Lamb, 2004), blogs (P. Duffy & Bruns, 2006; Williams & Jacobs, 2004), podcasts (Lum, 2006), and video-sharing sites such as YouTube (Bonk, 2008) to education, so these Web 2.0 technologies will certainly be powerful tools for instruction as well as communication.

5.2 General student data. One type of data the LMS will be responsible for handling is student data. These data will include the student's name, address, birth date, parent information, health information, attendance, and so forth. However, in supporting the learner-centered paradigm of education, the LMS will also handle student information necessary for supporting information-age schools, which have moved beyond the current constraints of grade levels, class periods, and so forth. Therefore, the LMS will also manage such student data as who the student's mentor-teacher is, records of major life events, what school or learning community the student belongs to, the student's home room, and community organizations he or she is involved with. It will also keep track of the physical location of the student by radio-frequency identification (RFID) or by the student "swiping" his or her student identification card when entering or leaving a school room or building, as most students will not be restricted to set rooms at set times. In sum, the management of student data will be a key function of an information-age LMS. The LMS will gather, secure, and allow easy management of data such as those described above in order to effectively support the truly learner-centered environment necessary to meet the needs of today's communities and their learners.

5.3 School personnel information. The third secondary function is the management of school personnel

information. As an LMS is systemic in nature (W. R. Watson, S. Lee, & C. M. Reigeluth, 2007; W. R. Watson & Watson, 2007) and responsible for managing the entire learning process of a learning organization (Szabo & Flesher, 2002), it needs to be capable of managing all of the data related to learning, including that of the school personnel. These data will include general information, such as name and address, but also data related to learner-centered instruction, such as assigned students, certifications and awards received, professional development plan and progress, and the teacher's physical location (again managed through RFID or card-swipes). These data will also serve the teacher in providing evidence of excellence by identifying awards and recognitions received by students and storing samples of exemplary student work and evidence of learning. Additional information will be tied directly to the teacher's instructional activities and will include learning objects, other instructional components, and assessments developed by the teacher, as well as records of student evaluations performed by the teacher. Proper management of this information by the LMS will support the new role of teachers as facilitators, coaches, and mentors that is required in a learner-centered environment (McCombs & Whisler, 1997).

5.4 LMS administration. Another secondary function focuses on administration of the LMS itself. As software that manages the entire learning process, the LMS will necessarily gather and store a great deal of data, including some that is sensitive. An important feature of the LMS will therefore be supporting the administration of these data and providing and restricting access to them. While it will be extremely important that data such as medical records and Social Security numbers be kept secure by the LMS, it will also be important that proper access to data and the LMS' reporting features be handled in a consistent and efficient manner. The ability to input, retrieve, and update data will be managed by user role. Therefore, some teachers will have access to some of a student's personal information, such as attendance records, parents' names and contact information, and so forth; and some support personnel, such as a school nurse and a guidance counselor, will have access to other personal information, such as physical and mental health records. Furthermore, data will be kept not only on students, but also on teachers and staff. It is therefore very important that the LMS will offer strict security while still providing appropriate access to data in order to effectively support the information needs of the school or school district personnel.

This section has highlighted some secondary functions that an information-age LMS will provide. These include functions related to communication, general student information, school personnel information, and LMS administration, and there are certainly others that we have not mentioned here. However, it is not appropriate for an LMS to address purely administrative functions, such as budgeting, payroll, and purchasing.

Conclusion

It should be apparent that technology will play a crucial role in the success of the information-age paradigm of education. It will enable a quantum improvement in student learning, and likely at a lower cost per student per year than in the current industrial-age paradigm. Just as the electronic spreadsheet made the accountant's job quicker, easier, and less expensive, the kind of LMS described here will make the teacher's job quicker, easier, and less expensive.

LMS fills a primary necessity for truly learner-centered instruction by freeing teachers to take on their new roles in a learner-centered environment: facilitators, counselors, and coaches, rather than being the main source of instructional content (McCombs & Whisler, 1997). In order to support this, an LMS will provide a variety of instructional features that allow teachers to truly customize learning for each learner, and to facilitate choice and control for the learners as they work towards mastery of required attainments and deep knowledge of all standard subjects and skills. Furthermore, an LMS will support students directly in their new roles, as active agents of their own learning (Schlechty, 2002).

However, such dramatic changes in the roles of teachers, students, parents, and technology are not easy to navigate. They require dramatic changes in mindsets about education for all those involved, and this requires a systemic transformation process that is carefully conceived and executed. The School System Transformation (SST) Protocol (F. M. Duffy & Reigeluth, 2008, the second article in this four-part series) is a well developed and field tested guidance system for helping school districts to engage in such transformational change. The problem is that paradigm change is a time-intensive and therefore expensive process that requires considerable resources as well as expertise in the transformation process. The SST Protocol is not enough. It is our sincere hope that the FutureMinds Initiative (Reigeluth & Duffy, 2008, the first article in this series) will help state departments of education to build the capacity to provide both the resources and the expertise needed for successful paradigm change. □

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