Learning Management Systems of the Future: A Theoretical Framework and Design

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Abstract

While American institutions of higher education still lead the world in quality of instruction, research and service, certain trends are challenging their future. Immediate attention to resolving these issues is necessary if the American university is going to maintain world leadership in the foreseeable future. The theory of transactional distance is put forward as a roadmap for changing the industrial system of education to a post-industrial one in which each learner receives differential instruction based on his or her prior knowledge of the subject matter, learning preferences and metacognitive states. Management of learning and teaching is described in a dynamic environment in which learners can participate in defining the level of autonomy with which they are comfortable, and instructors can set the required level of structure according to the characteristics of each discipline taught thus providing the appropriate level of transactional distance at each point in time for each individual learner. Ramifications of this environment for the structure of the university are discussed and components of a future educational management system are specified.

Keywords: Learning management, dynamic instructional design, transactional distance, learner autonomy, instructor control, distance education

Introduction

The learning management system (LMS) has become the primary software for developing and offering courses taught at a distance in most American institutions of higher education, K-12 schools, businesses and government, including the military. This article focuses on the design of the next generation of such systems in higher education institutions. It offers a theoretical framework that is inspired by the concept of transactional distance as presented by (Moore 1973, 1983, 2005, 2007). The proposed system addresses some of the major challenges for universities, such as increasing costs and time-to-degree. Its validity will depend on effectively dealing with these problems.

For theoretical as well as practical reasons the LMS of the future should be able to integrate the operational processes of an institution directly related to learners, instructors, instructional designers and administrators performing their tasks in a seamless architecture. Therefore, it is more appropriate to name such a system an educational management system (EMS).

The EMS of the future, as conceptualized in this article, will have a significant impact on keeping the system of higher education relevant to the needs of its students, faculty and administrators in the remainder of the 21st century. As the university has become the primary engine of the knowledge society, its future is of utmost importance to the prosperity and security of the nation in the post-industrial era. Therefore, reengineering higher education through the creation of an EMS should be taken as a serious national priority.

While American institutions of higher education still lead the world, certain trends are challenging their future (Arenson, 2003; Douglas, 2006; The State Higher Education Executive Officers, 2005; U.S.

Department of Education, 2006).
These Trends include:

- Access- Students are facing difficulty with entering higher education and completing their programs on time due to a combination of the following factors:
  - Inadequate preparation in high school
  - Lack of adequate information about college programs and what students can expect to gain from each program
  - Lack of alignment between standards and expectations of high-school programs and those of the college
  - Increasing financial barriers due to repeated tuition hikes and escalating cost of room and board, transportation and other necessities, such as books
  - Inadequate capacity to respond to the needs of 12 million self-supporting adults age 25 and older who participate in credential and degree programs
- Cost- A steady increase in the total cost of higher education has been due to:
  - Tuition increases that exceed inflation and rate of increase in family income
  - A steady decrease in the share of state governments' allocation to funding higher education
  - Disproportionate increase in administrative costs as compared to instructional expenditures
  - Lack of incentives in reducing administrative and operating costs, since university budgets are insulated by third-party donations, and grants
  - Excessive federal and state regulations
- Access and cost issues have resulted in
  - Creation of confusing federal programs for financial aid to students
  - Discouraging students, especially from low income families, to attend college
  - Dramatic increase in the level of student debt while in college and for years after graduation
- Transparency and Accountability- Students and their families face confusion because of a chronic lack of clear, accessible information about colleges and universities, ranging from available financial aid, course completion rates, graduation rates and student success in finding appropriate employment after graduation and retaining their positions in the job market.
- Learning- American institutions of higher education that led in student achievement and Noble Prize winners among faculty in the world are losing their competitive edge in comparison to European and, in certain cases, Chinese and Indian institutions. Employers in the private sector as well as the government and not-for-profit institutions find recent college graduates often unprepared for the work world and have to invest in their education and retraining. Similarly, there has been a steady decline in "prose literacy," or the ability to understand a newspaper article and a remarkable lack of interest among American-born students in enrolling for courses in science, engineering, technology, and mathematics.
- Innovation- Regulations set in another time and age to increase quality and prevent fraud are hampering institutions of higher education from experimenting with innovative means in increasing student achievement, reducing costs, and improving efficiency in management practices. Other factors impeding innovation include:
  - Traditional academic calendars that reduce flexibility for educators and students
  - Lack of inter-institutional recognition of transfer credit that puts undue barriers in students' academic progress

- Lack of reform in accreditation and regulations that were designed to improve quality but are now hampering change
- Lack of interdisciplinary programs to meet the demands of businesses, the government and other institutions in the 21st century.

Despite these problems, there is no doubt that the American system of higher education is a vital and indispensable engine for today's economy. Employers are highly dependent on an educated work force. Their companies also rely on research and development efforts of universities. Immediate attention to resolving these issues is necessary at this point if the American university is going to keep its world leadership.

The true power of the computer-telecommunication nexus is in offering personalized learning and performance support systems in a dynamic environment that can adjust to the prior knowledge of the learner, as well as his or her learning preferences and meta-cognitive states. The current one-size-fits all system locks students in courses that are not time-efficient, thus increasing the overall costs for them as well as their time-to-degree. Without change, the U.S. system of higher education will not be able to attain the goals set forward by the U. S. Department of Education (2006):

- We want a world-class higher-education system that creates new knowledge, contributes to economic prosperity and global competitiveness, and empowers citizens.
- We want a system that is accessible to all Americans, throughout their lives.
- We want postsecondary institutions to provide high-quality instruction while improving their efficiency in order to be more affordable to the students, taxpayers, and donors who sustain them.
- We want a higher-education system that gives Americans the workplace skills they need to adapt to a rapidly changing economy.
- We want postsecondary institutions to adapt to a world altered by technology, changing demographics and globalization, in which the higher-education landscape includes new providers and new paradigms, from for-profit universities to distance learning (p. viii).

Contemporary Distance Education Theory

Contemporary distance education theory and research offer a fundamentally different form of education as compared to today's education, training and performance support systems. While the structure of the current university is industrial, students have to work and prosper in the post-industrial era. More than two decades ago, in reflecting on the history and condition of educational institutions, Toffler (1980) posited:

> Built on the factory model, mass education taught basic reading, writing, arithmetic, a bit of history and other subjects. This was the "overt curriculum." But beneath it lay an invisible or "covert curriculum" that was far more basic. It consisted –and still does in most industrial nations – of three courses: one in punctuality, one in obedience, and one in rote, repetitive work. Factory labor demanded workers who showed up on time, especially assembly-line hands. It demanded workers who would take orders from a management hierarchy without questioning, and it demanded men and women prepared to slave away at machines or in offices performing brutally repetitious operations. (p. 29)

How students are credited and tested is also important in industrialized mass education. Students receive credit for the number of hours they spend in a classroom. The budget of state institutions of higher education is pegged to student seat time. Thus institutions are rewarded by mere presence of students on campus and not necessarily based on what learners accomplish. When students are assessed for learning outcomes, the examination for such evaluation is most often a standardized test.
This form of assessment has been supporting standardization in education and has greatly contributed to institutionalization of homogeneity around the most common denominator in performance. There is no doubt that learners must acquire certain basic skills to survive in a complex economy. Objective evaluation of these skills is a necessity , however, in recent years, standardized tests have come under scrutiny and their value heavily criticized. Sacks (1999) argued that standardized tests have questionable

value in predicting a student's academic success. Further, they "…reward passive, superficial learning, drive instruction in undesirable directions, and thwart meaningful educational reform." (p. 8)

As industrial measures were introduced to educational institutions, they became more efficient in offering more seat time to students. The paradox of industrial management of education for individual learners was that it facilitated participation, but imposed a covert curriculum which will no longer benefits students in the emerging post-industrial era.

In search of a more inclusive theory of distance education, Moore (1973, 1983) reviewed more than 2,000 published articles in scholarly journals. These covered a wide range of topics, but included articles on open, continuing, and adult education as well as independent learning. Moore noticed a developing pattern and identified two shared primary concepts: *dialog* and *structure*.

According to Moore (1983),

> "Dialogue describes the extent to which, in any educational programme, learner and educator are able to respond to each other. This is determined by the content or subject matter which is studied, by the educational philosophy of the educator, by the personalities of educator and learner, and by environmental factors, the most important of which is the medium of communication" (p. 157).

He continued:

> Structure is a measure of an educational programme's responsiveness to learner's individual needs. It expresses the extent to which educational objectives, teaching strategies and evaluation methods are prepared for, or can be adapted to the objectives, strategies, and evaluation methods of the learner. In a highly structured educational programme, the objectives and the methods to be used are determined for the learner and are inflexible. (p. 157)

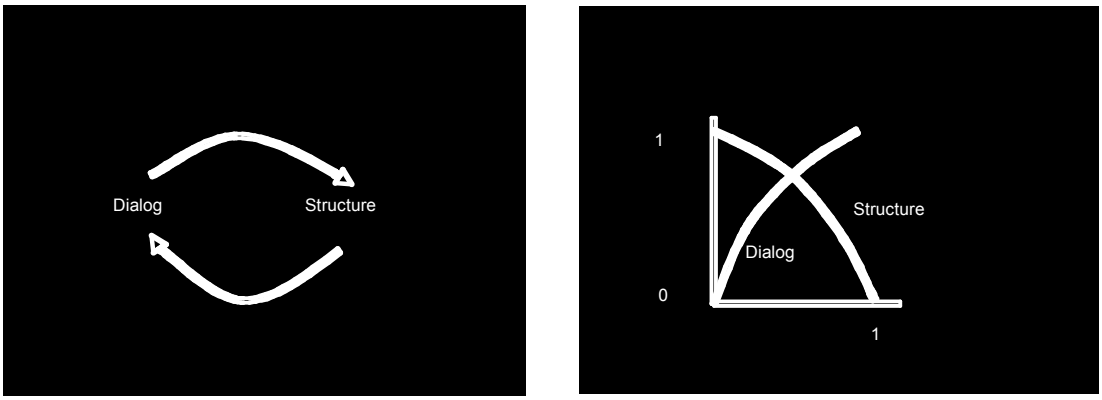

Figure 1. Inverse relation between dialog and structure

Realizing that these variables determine the *degree of separation* between the learner and the educator, he defined *transactional distance* as a function of these two variables. He explained: "In a programme in which there is little structure, and dialogue is easy, interaction between learner and teacher permits very personal and individual learning and teaching."

Using the variables *dialogue* (D) and *structure* (S), Moore proposed four possible sets to classify individual learning programs.

1. Programs with no dialogue and no structure (– D – S)
2. Programs with no dialogue but with structure (– D + S)
3. Programs with dialogue and structure (+ D + S)
4. Programs with dialog and no structure (+ D – S)

Viewing distance as a variable that should and can change depending on the requirements of the instructor for structure, and the needs of the learner for dialog, had major theoretical and practical ramifications.

- Moore shifted distance in education from its grounding in physical science to social science. In the physical science paradigm, distance in education is conceptualized as a pre-determined and fixed geographical separation measured in miles and kilometers. Transactional distance, defined by the *relationship* between the teacher and the learner, is measured in terms of *dialog* and *structure*.
- Such relationship was evident in mass distance education systems, where the same educational message was distributed to many students via radio or television (high structure). However, with the advent of the computer, it became possible to individualize instruction, and with the computer/telecommunication nexus, it is now possible to extend "mass customized" and individualized education to learners.

The theory of transactional distance offers a roadmap for changing the current industrial system of education to a post-industrial one in which each learner receives differential instruction based on his or her prior knowledge of the subject matter, learning preferences and metacognitive states. No longer is seat time a valid unit of funding, or institutional performance but how each institution is capable of providing the proper balance between requisite structure, and desired autonomy at each moment in time for each individual learner during the process of teaching and learning.

A Plausible Scenario

Learning in the university of the future is very different from how it is practiced today. There is no set curriculum to study or time- and space-based classes to attend. Because of these major differences, students enrolling in the institution of the future must go through an intense training process in how to learn and to become fully cognizant of their metacognitive abilities. This learning process, although intense at the outset for the EMS, is not a one-time event. Students reassess their learning abilities periodically either on their own or with the aid of a counselor. As they progress towards completing their program of study, they may repeat some of their earlier learning exercises to keep their abilities sharp and up-to-date.

In this scenario, learning is interdisciplinary. Students achieve certain life aspirations, such as developing necessary skills for a career in engineering, nursing or accounting, but their learning is not defined by pre-set courses; it is determined by a learning contract with the institution. Each learner develops a unique learning contract with the institution in which s/he is enrolled. These contracts are based on:

- Assessing prior learning of specific skills and knowledge domains relevant to the learner's personal and career aspirations
- Defining specific lifelong learning goals
- Defining specific short-term goals for qualifying for a new career or promotion in a current career
- Defining learning objectives in specific time intervals to reach career objectives and lifelong goals

Assessment and goal setting will not be a one-session affair with an undergraduate advisor. The student will work with a counselor on a regular basis to assess lifelong interests, career objectives, and how prior knowledge and competencies may assist in lifelong interests and career goals. Counseling and advising will also include introduction to career options, especially those needed in the future by business and government. Thus, depending on the background, profile, and preparedness of the student, s/he will spend a considerable amount of time in lifelong goals, career options, and strengths and weaknesses in basic skills. The deliverable product of this exercise will be a learning contract with the institution. The learning contract is therefore a map for the student and a blueprint for the institution to provide the necessary learning experience and monitor progress.

Today, we know education providers as universities, libraries, museums, theme parks, publishers, corporations, and government agencies. In the future, almost all institutions and many individuals working

on their own would become knowledge providers on the Internet. Many who may have never had a chance to teach or mentor a student may do so on their own or in association with an education provider or enrolling institution. On the Internet, however, the student must now become a wise consumer of knowledge and skills and find appropriate, reliable learning opportunities wherever they may be.

Each enrolling institution may have a set of foundational learning objects for students so the learner does not have to spend time searching for and evaluating them. These foundational pieces may have been created by the enrolling institution or adopted from resources already in existence. A primary criterion for selection and adoption of a knowledge provider either by a single student or an institution would be to what extent the provider offers a dynamic teaching and learning environment. Fulfilling the terms of the learning contract with the institution in which the learner is enrolled would be greatly facilitated if the teaching/learning provider would have the capability of differentially responding to the needs of each learner.

Counseling and assessment in this scenario are periodic events. The institution is obligated to monitor the learner and the learner is obligated to demonstrate his/her progress in fulfilling the terms and objectives of the learning contract at specific time intervals. The learning contract, therefore, can be revised periodically to reflect the intellectual growth and personal maturity of the learner as well as his or her improvement in acquiring various skills and knowledge domains.

States would reimburse enrolling institutions for managing learning contracts and monitoring learner progress. Reimbursement would be based on how individual student needs are met in successful completion of their learning contract terms, rather than based on the number of enrolled students. Students would directly pay knowledge and skill providers with state-issued electronic vouchers when they successfully complete and perform a learning task. This market condition would provide the necessary competition among knowledge and skill providers as effective managers of the level of transactional distance for each student. Inevitably, this means that those involved in provision of knowledge and skills on the Internet must conduct the necessary research to develop and create effective learning objects, instructional strategies, and performance environments in a wide range of subjects and learning circumstances and for a variety of learning abilities.

Knowledge providers can compete for state, federal, and private foundation dollars for conducting discipline-based basic and applied research in learning and instructional sciences. Enrolling institutions, therefore, can decide whether they wish to remain comprehensive in offering all aspects of education-including learning contract management, research, and provision of knowledge, skills, and community service, or specialize in only one or a combination of these missions. Remaining comprehensive, however, would become more difficult as specialization grows and competition becomes intense. Some institutions may decide to rid themselves as much as possible of the heavy burden of an often city-sized infrastructure. With students not dependent on classrooms for becoming skillful and knowledgeable, institutions would have smaller campuses without sizable student housing or dormitories on the premises. Also, not all institutions would need to keep sports facilities, libraries, or food preparation and vending facilities. They could reduce their security forces, firefighting capabilities, parking facilities and other similar operations that increase overhead costs and make maintaining a university campus an immensely expensive venture.

In this scenario, a national system would be devised for offering basic campus services to students affiliated with many knowledge and skill providers for their learning, depending on their profile and needs. While the enrolling institution can offer student housing, food, sports and health facilities, new companies may emerge for providing such services to anyone holding a national student card in an accredited enrolling institution. Students enrolled in an institution physically located in San Francisco could use their card for sports or health facilities in New York if the enrolling institution is part of the national system.
The lack of physical campuses and classmates would not necessarily prohibit students from experiencing what is generally known as *campus life,* which refers to the social functions of an institution. Student organizations can continue on the Internet as well as on the ground, albeit the mix of participating students may not be defined by the geographic location of the institution in which they are enrolled, but by their social and academic interest among other factors.

In this case, institutions would be free from their custodial obligations in various degrees, which would provide them the opportunity to concentrate on their preference for their future growth and development. Enrolling institutions, depending on the interests and specialties of their resident faculty, may engage in developing new learning objects, materials and experiences. In the new environment, however, this cannot be a solo affair without the help of others such as instructional designers, programmers and videographers. Faculty would work with a team of specialists to create learning objects that are not only viable within an enrolling institution, but would be desirable by other institutions as well. Since division of labor and provision of necessary technologies for creating these new learning objects are costly, it is important that new materials are created either with marketing and sales in mind, or by amortizing the cost of their production over as many students as possible to make development of instructional materials financially viable.

Enrolling institutions may also engage in research to make the workplace more interesting for their faculty in contributing to generation of new knowledge. Graduate programs may require research from their faculty while the undergraduate programs may emphasize teaching. What is certain is that the faculty is not departmentalized in disciplines to conduct research, teach, or develop new learning environments. Increasingly, as these institutions mature, a team of experts will become responsible for teaching students and supervising their research, special studies, creative performances, theses, and dissertations. Faculty will also work in teams to conduct research as it is becoming increasingly difficult for one person to have the knowledge and skill to tackle the complex and multifaceted problems in social or physical sciences. Teaching, research, and development teams will form as needed around specific programs and projects and dissolve after they have fulfilled their mission. The idea of the department as a permanent unit to which the faculty belongs will become increasingly difficult to maintain and departments will eventually disappear to make way for faculty to collaborate on problems that require a host of integrated approaches.

Students will also work in teams for research and development, not necessarily with those who are in their enrolling institution, but those in other enrolling universities with whom they share a common academic interest. This dynamic environment will provide cross-fertilization of ideas, methods, and processes at a level of intensity and quality and across disciplines that was not previously available.

Although some or all aspects of this scenario may sound new and perhaps impractical, some of the suggestions made here were tried on an experimental basis by leaders in the field of distance education in the 1980s and 1990s as early research and development was progressing at a rapid rate. Faculty of leading institutions taught courses in teams across the country using simple phone lines. (Gunawardena, Lowe, and Anderson, 1997). They also put teams together to conduct research on various aspects of computer-mediated communication as it pertained to teaching and learning. Although these experiments were successful in demonstrating the feasibility of such formats in teaching and research for students, they were not supportable by the structure of the institutions in which the demonstration projects took place. Therefore, re-engineering the university's administration and management is an imperative in this scenario.

Offering service by enrolling institutions can transcend the boundaries of the immediate community and involve individuals or groups wherever they may be. As human assets and intellectual property become more important in the economy of the future, each faculty member will have to decide a) the extent to which s/he should be involved in service activities and b) to what extent s/he devotes his/her time and effort in research and development. It is of utmost importance that faculty sign contracts with their respective institutions that articulate their obligations regarding time and intellectual property. Specific legal arrangements must be made for each faculty member's human and intellectual capital and assets. Faculty would be well advised to receive coaching in advance of accepting a position at an enrolling institution, similar to professional athletes when they join a team.

Managing such an enterprise would be very different than how universities are administered today. Much of the capital-intensive infrastructure of the universities would be unnecessary when students and faculty do most of their work on a computer networked by the Internet. Administrators would not be involved in decisions about the physical structure of the university but its virtual configuration. Managing students that work in teams and are involved in multidisciplinary studies with faculty and peers who may not be affiliated at the enrolling institution is a different task than managing an industrial campus with lock-step

courses and one-size-fits-all academic programs and calendars. Such an enterprise cannot be run without the Education Management System of the Future; more importantly, those who do not share the same vision as it is presented in this scenario will not be able to manage it. Leadership will become extremely important to put this scenario to work.

Components for Education Management System of the Future

The EMS of the future should have the following components:

- Macro Level Specifications- At this level, the most important design consideration is for the system to serve instructional designers, faculty, tutors, help-desk attendants, students and administrators at various levels in a seamless architecture.
    - Stakeholders and users should be able to use the same databases for finding the information they need or performing the tasks required of them. Each subsystem in turn would inform the other subsystems about the necessary processes for each stakeholder to carry out their daily tasks.
    - Administrators should be able to track incoming potential students, screen their qualifications, register the qualified applicants and track their progress throughout their learning experience.
    - Instructional designers should be able to create the following environments using the system:
        - Shells for instructional strategies to be prescribed or recommended by instructors or selected by learners. Examples of instructional strategy shells (ISS) would be problem-based scenarios, simulations, drill and practice, and other similar methods.
        - Instructional/learning objects that could be used in some or all of these shells, depending on instructor and learner control.
        - Adaptive devices for learners to select a range of variables from font sizes and text density on the screen to cognitive load, and amount of mental effort required for completing a learning task.
        - Automated functions to offer an appropriate combination of instructional/learning objects and ISS through AI engines or XML or other forms of adaptive software.
        - A dynamic structure to offer optimal transactional distance to individual students and their instructors as the process of teaching and learning progresses at each moment in time.
    - Students should be able to register for learning experiences and become engaged in the learning process according to their knowledge and aptitude. In particular, students should be able to:
        - Access live or automated counselors to develop an individual plan of study depending on their current learning requirements as well as current or future career aspirations.
        - Sample learning materials.
        - Learn about the background of the faculty.
        - Receive information about accreditation status of the institution and its programs.
        - Make payments for registration, apply for and receive loans.
        - Dynamically access their enrollment status.
        - Dynamically receive feedback on their performance in a learning experience and progress they make toward completion of a plan of study.

- Study Management. This set of specifications is for students to be able to manage their time, process of learning and metacognitive ability. Components include:
    - Dynamic and personal calendar of learning activities, assignments and administrative deadlines for each individual student. Students can enroll in learning experiences as frequently as their progress allow. A good start would be the ability to enroll at least 12 times a year as compared to the current two or three opportunities and form cohorts that can support each other socially. Each individual, however, should be able to follow his or her personal plan of study. In due time, with more frequent enrollment opportunities, students would be able to self-organize in different groups to socialize and support each other in learning tasks.
    - Assess learning preferences of each student and develop a learning profile as a guide to manage study habits, metacognition and general academic experience leading to success.
    - Set learning preferences for time and place of study as well as milestones for completing the individual plan of study for each student.
    - Micro instructional design- this specification is for instructional designers to be able to design learning environments for pre-set learning and instructional frameworks. These frameworks provide a wide range of possibilities for the instructor and the learner to choose from for meeting the objectives of the learner in completion of his/her individual learning plan.
- Structure- Refers to a dynamic capability for the instructor to control the process of teaching in relation to dialog and learner control.
- Instructor Control- The instructor will be able to:
    - Communicate with the learner on specific intervals, depending on his/her need for such communication and in relation to the learner control. Communication will be synchronous or asynchronous, depending on the context, and will include live two-way audio, video, text, screen sharing, document sharing, desktop sharing or a combination of these media.
    - Provide a rich array of instructional information for the learner.
- Dialog and Learner Control- This set of specifications refers to a dynamic capability for the student to control the process of learning in relation to structure and instructor control.
- Learner Control- The learner will be able to:
    - Communicate with the instructor on specific intervals, depending on his/her need for such communication and in relation to instructor control. Communication will be synchronous or asynchronous, depending on the context, and will include live two-way audio, video, text, screen sharing, document sharing, desktop sharing, or a combination of these media.
    - Communicate with teaching assistants, help desk attendants and other instructional service providers.
    - Communicate with his/her cohort and others sharing the same learning interests and experiences.
    - Access a rich array of instructional information to dynamically adapt to the learner's preferences.
- Autonomy and Creativity- Refers to the learner's ability to exercise autonomy in reaching learning goals that might be included in the learning plan or go beyond the previously stated objectives.
    - Provide learner with a rich environment for exploration.
    - Offer relevant environments for learner to develop new ideas, experiment with such ideas and transfer them to novel situations.

  - Provide supportive and corrective dynamic feedback to learner.
  - Prompt instructor to intervene at appropriate times.

- Citizenship- This set of specifications refers to students' access to experiences related to student governance, student run "newspapers," broadcasts and Webcasts, as well as participating in speeches, concerts, sporting events and other student body activities. Because each student will take a different route for learning, the citizenship experience for forming and sustaining virtual communities in a meaningful way becomes very important. The more personalized the instruction, the more need for citizenship activities.

The design and development of the educational management system of the future will have to resolve and overcome some of the perennial problems in instructional design and educational technology. A prime example is keeping instructional content and the instructional design context separate. This would be for selecting the most appropriate content and context in relation to the instructor's requirement for structure and learner's desire for dialog during the course of an instructional/learning session at each moment in time. Emerging technologies, such as Web 3.0 applications, indicate that we are on the cusp of new discoveries in instructional and learning sciences and technology, and with appropriate time, investment and attention, this and similar problems would be overcome.

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