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Health Professionals' Views of Informatics Education:

Findings from the AMIA 1999 Spring Conference

NANCY STAGGERS, PHD, RN, FAAN, CAROLE A. GASSERT, PHD, RN, FAAN, DIANE J. SKIBA, PHD

Abstract Health care leaders emphasize the need to include information technology and informatics concepts in formal education programs, yet integration of informatics into health educational programs has progressed slowly. The AMIA 1999 Spring Congress was held to address informatics educational issues across health professions, including the educational needs in the various health professions, goals for health informatics education, and implementation strategies to achieve these goals. This paper presents the results from AMIA work groups focused on informatics education for non-informatics health professionals. In the categories of informatics needs, goals, and strategies, conference attendees suggested elements in these areas: educational responsibilities for faculty and students, organizational responsibilities, core computer skills and informatics knowledge, how to learn informatics skills, and resources required to implement educational strategies.

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Affiliations of the authors: University of Utah, Salt Lake City, Utah (NS); Health Resources and Services Administration, Department of Health and Human Services, Rockville, Maryland (CG); University of Colorado, Denver (DJS).

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Correspondence and reprints: Nancy Stagger, PhD, RN, FAAN, College of Nursing, University of Utah, 10 S. 2000 E. Front, Salt Lake City, UT 84112; e-mail: <nancy.staggers@nurs.utah.edu>.

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Health care leaders emphasize the need to include information technology and informatics concepts in formal education programs.[1–4] The Pew Commission[4] stated that the effective and appropriate use of communication and information technologies was 1 of 21 essential competencies needed by all health professionals. The Association of American Medical Colleges (AAMC) recognized that medical schools needed to update curricula to include advances in information technology and medical informatics to ensure that the curricula are more reflective of contemporary medical practice.[5] The AAMC objectives outline foundational

informatics competencies needed by physicians in the 21st century and assume that medical students have mastered basic computer literacy skills. The stated objectives cover informatics topics for five interwoven physician roles: clinician, researcher, educator, manager, and lifelong learner.

In nursing, the need for informatics education is echoed by the American Association of Colleges of Nursing (AACN)[1,2] and the National Advisory Council on Nursing Education and Practice (NACNEP).[6] The AACN affirmed that in the next decade, all higher education in nursing must address priorities to include the management of data and technology.[1,2] Seven broad guidelines related to information and health care technologies are outlined. The NACNEP released a national agenda in 1997, calling for the education of nursing students and practicing nurses in core informatics content, the preparation of nurses with specialized knowledge in informatics, preparation of nursing faculty, and the facilitation of informatics projects through collaboration among public and private sectors.[3,6] This publication was a call to action but did not include specifics about core informatics content.

Health sciences librarians are also very interested in the field of informatics. Over the past decade, several surveys have been conducted to identify knowledge and skills necessary for the future health sciences librarians. The first survey, conducted in 1993, was based on the work of the Medical Library Association (MLA) Task Force for Knowledge and Skills. The results, according to Roper and Mayfield,[7] reported deficiencies in the area of telecommunication, networking, budgeting, software, and planning.

The second survey, based on the work of the MLA Research Task Force, called into question the need for advanced research skills.[8] In more recent years, several articles emphasized the need for medical librarians to become knowledgeable about biomedical informatics.[9–11] In 1997, Giuse et al.[10] reported on the results of an extensive project to identify necessary knowledge and skills sets as well as to build a learning model to support lifelong learning. The most interesting results were the comparisons between users' and librarians' views of these necessary future skills. According to the study, users ranked traditional librarian skills as the most important, whereas librarians rated personal characteristics such as ability to work in teams, innovativeness, and leadership as the most important. The findings of the study resonated with higher education beliefs by stressing skills like critical and analytic thinking rather than focusing solely on content.

The International Medical Informatics Association (IMIA) Group on Health and Medical Informatics Education drafted broad guidelines in 1999 for health informatics competencies and informatics education for all health professionals.[12] These guidelines delineated learning outcomes for all health care professionals and those health care professionals specializing in health and medical informatics. The guidelines have been endorsed by the IMIA Board.

Despite these activities, the integration of informatics into formal health educational programs has progressed slowly. In medicine, Espino and Levine[13] found that literature searching, clinical decision making, and the Internet were being taught in 26 schools of medicine and 6 medical informatics programs, but the lack of interested and knowledgeable faculty was a primary difficulty in the further implementation of informatics into medical curricula. Johnson[14] conducted an empirical study of schools of nursing and found that, in the early 1990s, computer literacy was the only area of emphasis not addressed by the majority of accredited baccalaureate nursing programs. Two recent studies indicate that informatics integration into nursing curricula has not improved. Carty and Rosenfeld[15] discovered that less than one third of nursing programs in the United States even addressed informatics in their curricula. Austin[16] reported that only 3 of 60 computer literacy skills were being integrated into teaching practice by nursing faculty.

Clearly, there is consensus about the need for informatics education across health care professions. The AMIA 1999 Spring Congress was held to begin to address these issues across health professions, focusing on the educational needs in the various health professions, goals for health informatics education, and implementation strategies to achieve these goals.

Overview of the Spring Congress

The AMIA Spring Congress was held May 25–27, 1999, in Chicago, Illinois. The two-and-a-half-day conference used a working format, a new approach for the Spring Congress. It blended invited panels and structured breakout discussion sessions to focus on current issues and future predictions for health informatics education for three groups of participants—health informatics researchers, health informatics administrators, and health professionals. The conference explored the impact of changes in higher education on health informatics education, the impact of health care changes on the employment of health informatics professionals, and the requirements for health informatics education.

The conference attracted 244 international attendees, including physicians, nurses, medical librarians, and health education and medical records professionals. This paper addresses the methods and findings from the health professions sessions, a track addressing education of non-informatics health professionals.

Methods

Prior to each breakout session, panels of speakers addressed the general assembly of conference attendees about relevant health informatics education issues for 90 minutes. Conference attendees then selected a subsequent 90-minute working session to attend. Attendees were free to move from session to session if they wished. This format was repeated for each of three breakouts, so participants focused on needs, goals, and solutions for future health informatics education.

The health professions track had the largest number of conference attendees, more than 130 in the first two days and more than 90 on the last half day. Probably because the health professions track addressed informatics educational needs of health professionals, it attracted many non-informatics professionals from all the disciplines mentioned earlier. Many participants were new to AMIA. Session attendees sat at tables in groups of eight to ten. During Day 1, the moderators directed an interdisciplinary seating arrangement. Subsequently, participants self-selected their seats, maintaining both their original groups and an interdisciplinary mix at each table.

The working sessions were led by moderators, who developed specific track goals and processes for the three sessions. The moderators for the health professions track were Carole Gassert, PhD, RN, Diane Skiba, PhD, and Nancy Staggers, PhD, RN, FAAN. The goals for these sessions mirrored the conference goals: Day 1 addressed needs for informatics education of health professionals, Day 2 identified goals for the informatics education of health professionals, and Day 3 proposed strategies to meet the identified goals for the informatics education of health professionals.

The moderators introduced each day's topic and gave assignments to each small group. After the groups discussed their assigned topics, they recorded their main points on flip charts and subsequently presented their work to the other attendees. Before the day's instructions were given on Days 2 and 3, the moderators collated findings from the previous day and presented the summary to the attendees, being careful to preserve the ideas and wording of the small group participants.

Detailed Small Group Instructions

Four trends were identified by the moderators to initiate discussion about the needs of non-informatics health professionals for informatics education; specifically, integrated delivery systems, technology, the changing role of the patient in health care, and higher education. One of these four trends was assigned to each small group for discussion. The group built on the initial ideas in their trends or identified other important, associated trends. They then spent most of the session describing the health professionals' educational needs that are associated with their trend.

Based on the needs identified during Day 1, the small groups during Day 2 were asked to address informatics education goals for non-informatics health professionals in the year 2010. Using the information

Table 1 ■

Specific Instructions to Small Groups

Day 1:
Appoint a table leader.
Spend 15 minutes discussing and expanding on your trend.
Spend 45 minutes identifying needs for informatics education for non-informatics health professionals.
Spend 30 minutes presenting your group's major points and listening to other small-group presentations.
Day 2:
For the next 60 minutes, identify informatics knowledge domains and skill sets required of health professionals in the year 2010.
Spend 30 minutes presenting your major points and listening to other small-group presentations.
Day 3:
For the next 60 minutes, accomplish these three tasks:
■ Identify the types of informatics programs needed in 2010.
■ Determine how health care professionals should learn needed informatics knowledge and skills.
■ Outline five principles guiding this learning.
Identify unique resources required for successfully learning informatics skills.
Spend 30 minutes presenting your major points and listening to other small-group presentations.

from Days 1 and 2, the third breakout session focused on identifying strategies to effect informatics education for non-informatics health professionals. Specific instructions to the small groups for each day are shown in Table 1.

Findings from the Health Professionals Sessions

The attendees performed their assigned tasks in lively discussions. The findings discussed in the following paragraphs reflect concepts and ideas from the 90-minute sessions each day. Given the time available, the groups suggested ideas rather than providing extensive information about each subject.

Day 1: Trends and the Needs of Non-Informatics Health Professionals for Informatics Education

Groups spoke to the trend of integrated health delivery systems, including the fast pace of change in health care delivery systems, the penetration of managed care, and the increasing number of mergers between health delivery systems. All these compounded the speed of change in health care delivery. The groups mentioned the shift toward increasing volume of care delivery in the ambulatory setting, increasing the complexity of care there. Few attendees were from institutions that had clinical information systems in place to span the continuum of care in these integrated delivery systems. They expressed the need for data sharing and standards to facilitate patient care. Mergers among institutions made obvious nonstandard methods of patient care among facilities as well as the current difficulty of caring for patients across settings, and pointed up the need for standard methods of data sharing. In addition, the introduction into health care of evidenced-based practice has mandated a need for outcome management and systematic methods of patient care to include the use of protocols and interdisciplinary guidelines for care.

The groups outlined trends in technology, such as the convergence of technologies, faster processing speeds, miniaturization, and the emergence of bioinformatics. Other issues raised by the groups included the trend toward increasing numbers of databases and the need to use data mining and knowledge discovery techniques. These trends accorded with recent published findings, including government reports heralding the emergence of faster, smaller, and smarter technologies that will ultimately affect the ways we work, live, play, learn, and receive health care.

According to Steane and Rieffel,[17] miniaturization of components is projected to reach various strict physical limits in the next 10 to 20 years, thus ending the application of Moore's Law, which states that processing power will double every 18 months. Steane and Rieffel propose that computer processing power, dependent on nanotechnology, will increase by another 1,000 to 100,000 times the current speed, and that is all. These authors think that a combination of quantum mechanisms and computer science will take computing power to its next level. The effect of these advances in computing power means that many new hardware devices will become smaller, faster, and cheaper. Concomitant increases in storage capacity are also a natural evolution, possibly requiring terabyte hard disks and petabyte Web spaces.

In groups in which the role of the patient was discussed, greater access to health information was seen to increasingly empower patients. With more access to technology in the public arena, today's patients were described as being more assertive and more apt to use information gleaned from Internet resources to challenge providers' credibility. The groups thought that conflicts between recommendations by the provider and those from online resources would be a greater possibility than in the past. They also expressed concern about the growing "digital divide," whereby patients in the greatest need of health care have the least access to health care information for informed decision making.

Other information presented by groups included the fact that the amount of available health information is increasing via both the Internet and television. However, the quality of that information is still variable. In addition to the volume of available information, resources have allowed the public greater exposure to alternative and complementary therapies and other less conventional health treatments in Western medicine. Increased participation in discussion groups and support groups via the Internet has changed methods of support and information exchange. This type of participation and the increasing access to one's own health record may actually increase the demand for services and professional advice about particular therapies. Last, traditional sources for advertising, such as television, are merging with Internet sources, creating a varied environment in which both commercial and objective sources of health information appear in the same media.

Trends in higher education that were outlined by the groups included the use of innovative teaching methodologies and an emphasis on lifelong learning skills. The impact of electronic publishing, including

less lag time in publishing and a perception of less rigorous reviews, was discussed. The groups acknowledged the movement toward asynchronous communication between faculty and students with the use of electronic mail and other means of technology-assisted education. Technology-assisted educational opportunities were becoming more commonplace in health sciences education. Educational strategies ranged from the simple use of a web page to disseminate pathology slides to the use of virtual reality to simulate a surgery. The groups also emphasized the increasing demand for newer techniques and computer-mediated learning at a time when funding for higher education was decreasing.

The trends identified by the groups concurred with recent published findings in higher education. The higher education literature is replete with articles highlighting both sides of the computer-mediated learning debate. In the health sciences arena, wide disparities exist among schools in the use of technology-assisted learning. Some schools of medicine and nursing use "cutting edge" technologies, such as virtual reality and Web-based learning, while others continue to promote the use of lectures with the addition of computer-generated slides. Funding, innovative faculty, information infrastructures, and faculty knowledge of technology-assisted teaching and learning strategies are all essential ingredients for the successful implementation of newer computer-mediated learning opportunities. Like many faculty, the groups believed that students will demand newer methods and will therefore serve as catalysts for the integration of computer-mediated techniques in professional health education.

The small groups thought broadly about the need for informatics education for non-informatics health professionals and identified topics in three categories—needs for information education, educational responsibilities of faculty and students, and organizational responsibilities.

Needs for Information Education

- Health professionals should be open to new information and methods of evaluating health information that is not presented as formal research findings.
- Professionals need to learn how to critically appraise information sources and the content of information within sources, interpret information to patients of varying cultures, and identify good sources of information, including Web sites. These types of evaluation and informational skills also need to be taught to patients.
- Providers need to become more skilled at saying "I don't know" when presented with new information.
- Providers and patients need to deal with increasingly empowered patients as they monitor their own care, and deal with the issues this shift presents, e.g., patients monitoring themselves for blood pressure or glucose and making their own decisions based on information acquired from nontraditional sources.
- Informatics competencies should be identified for non-informatics health professionals. Computer skills are only one aspect of informatics competencies.

Educational Responsibilities of Faculty and Students

- Faculty and students need to accept that formal education is just the beginning of a lifelong process of learning, and to foster an earlier change to adult learning with increased responsibility for identifying one's own learning needs.
- They need to question the relevance of current curricula, their disconnect from "real life" in clinical care.
- Faculty can foster openness to changes in technology and should learn to exploit educational changes that technology can bring, as in asynchronous communication, use of multimedia, and emphasis on higher-level cognitive skills.
- Faculty must use technology themselves.
- Today's students expect to be entertained; therefore, faculty need to be trained to capture students' attention.
- The educational effectiveness of new educational technologies is still unproved and needs evaluative study.
- Faculty should de-emphasize the memorization of facts in formal programs, especially in medicine, and spend more time on integrative and evaluative skills. They need to teach to the changing role of providers as information interpreters.
- Faculty and students need to explore new styles of learning, such as just-in-time or on-demand methods for continuing education, collaborative work among faculty and students to emulate the team work required in health settings, and problem-based learning.

Responsibilities of Organizations

- Organizations must begin to value the use of computer-mediated communication in the provision of care, e.g., the use of e-mail to advise patients.

- Legal and ethical issues for new forms of communication, such as e-mail, need to be addressed at the organizational level.
- Strategies for dealing with changes in information systems should be part of every organization; e.g., executive "buy-in" at the beginning of a change, development of policies for confidentiality, knowledge about the process of change and the adoption of innovation, and the use of telemedicine.
- Information technology needs better human factors design to promote usability, and better information presentation to mitigate information overload.
- The benefits of technology use need to be demonstrated.

Although the groups had different assigned topics, four themes echoed among them. Groups indicated a need for critical evaluation of health information by both providers and patients and concomitantly identified a need for providers to learn to cope with better-informed patients. Another theme across groups was the need for data sharing and integration to support communication within and among health systems.

Third, groups were concerned about the ethics of digital decision making and general provisions for privacy and security of health data. A fourth theme was the need to stop performing business as usual in educating health professionals. Health care systems and leaders of educational programs need to freely explore various technologies to support clinical practice and facilitate the novel delivery of learning opportunities.

Day 2: The Goals of Informatics Education for Health Professionals

When given the task of identifying educational goals for the year 2010, participants immediately responded that education for the year 2010 was already here. Students in many formal programs today will begin practice in the year 2010. Thus, today's informatics education goals may be coming too late for those practitioners. For others, who are not in formal education programs, the large amount of material to learn in the future needs to be translated into planned time at work for acquiring new knowledge and skills.

A bolus of learning in formal programs will no longer be adequate, and continual learning is a more appropriate model. The educational goals listed below represent a synthesis of the goals identified among the groups and are divided into core competencies (informatics knowledge and systems skills) and related skills.

Core Competencies:
Informatics Knowledge and Skills

Despite the fact that we are in the midst of the information age, many providers still do not have the basic technology skills enabling them to use computers effectively. Therefore, the goals of informatics education include competency in the following core computer technology and information systems knowledge for diverse groups of providers:

- Software use, such as presentation graphics, word processing, simple databases, e-mail, Internet searches, decision support applications, telemedicine, and home monitoring
- Principles of interface design, human–computer interaction
- Principles of privacy, confidentiality, and security
- Ethical uses of information technology, and ethical decision-making in the digital age
- Knowledge of terminologies, taxonomies, standards, and communication methods
- The importance of user-driven clinical systems, and structured data to support evidence-based practice
- Methods of evaluating information and information technology
- Basic methods of software development—the process, how to get involved
- How to critically and efficiently process information
- Understanding the impact of technology use (and of its lack of use) on public health

More than just technology-related skills, health practitioners need to develop higher-level cognitive skills to deal with information. The small groups suggested that educational programs begin informatics education by teaching systems thinking, principles of population health care management, and methods for evidenced-based medicine. This foundational thinking would then help students transcend rote learning to formulate meaningful questions to answer using information technology, to perform critical thinking about information and technology, and determine how to filter and manage critical information. In addition, it would emphasize the way that informatics and clinical care are intertwined, with informatics support-

ing clinical care. Practitioners of the future need to understand how to make data useful to them in their practices through the use of techniques for organizing and synthesizing data.

Related Skills

Although the conference concentrated on informatics education, these health professionals thought that education needed to include other content, outside informatics and higher-level cognitive skills. In particular, the groups emphasized the need for understanding human relations and business processes. Traditional education in medicine stresses independent decision making by the practitioner, but future educational goals should include developing negotiation and team-building skills for health professionals instead. Following from that idea, teaching the use of communication technologies would facilitate communication among diverse communities of people for both providers and patients.

After team-building and other integrative skills, the curricular content mentioned most frequently across groups was related to business processes. These processes were viewed as intertwined with informatics—understanding the basic flow of monies in an organization, business process re-engineering, risk analysis, cost-benefit analysis, and generally how to maneuver in complex organizations. Last, groups suggested the topics of cultural diversity, patient preferences, and role changes that occur as patients become more computer-literate.

Day 3: Strategies for Informatics Education for Non-informatics Health Professionals

The facilitators received usable written comments about informatics strategies from six of the eight groups. One group did not submit written comments, and one group reflected on ways to learn medicine rather than ways to learn informatics skills.

How to Learn Informatics Skills

The various suggested strategies for learning informatics skills were analyzed to determine the common trends across groups. All groups agreed that mentoring would be a valuable format to use during informatics education. Mentoring could be provided through "power users," a community of learners with different levels of informatics skills, or by one individual learner to another learner. Most groups emphasized the need for hands-on projects and practice sessions in learning informatics. Four groups suggested an interdisciplinary approach to learning informatics skills, but one group felt a discipline-specific focus should be used. The groups that emphasized an interdisciplinary focus wanted informatics education to reflect the way that care is delivered, by teams of various health providers. Understanding the processes and practices of other providers and how information is integrated in patient care would then be underpinned by informatics support and education.

Three groups recommended each of the following strategies for learning informatics—case studies, just-in-time learning, and articulated informatics competency requirements. Two groups identified discovery learning and problem-based learning as important strategies in gaining informatics skills. Individual groups suggested that strategies should include ensuring access to resources, even from a distance; ensuring privacy during learning opportunities; and developing government initiatives to teach informatics. Groups agreed about the existence of various methods for learning informatics skills, such as hands-on experience in real-life situations, discovery and problem-based learning, mentoring, case studies, asynchronous learning, and interdisciplinary education.

Principles of Learning Informatics

Across the health professionals groups, the most common principles were relevancy of informatics education and top-level buy-in. Each of the following principles was identified as a guideline for informatics education:

- Focus on information rather than technology
- Include ethical issues
- Match a teaching style to an appropriate learning style
- Use a team approach for both teaching and learning informatics
- Teach professionals to adhere to standards and policies for security, ethics, and competency

Interestingly, only one of six groups suggested that formative evaluation and qualified educators are keys to the informatics education of health professionals.

Unique Resources Required for Learning Informatics

Not surprisingly, the most commonly named essential resource was equipment. This included hardware, software, and integrated networks. According to the groups, the next most frequently required resources were money and support staff. This finding is interesting, because institutions often fail to include support staff on the list of needed resources.

Groups named three required resources that relate to faculty. These essentials were faculty development, faculty buy-in to technology use, and faculty incentives, such as travel, merit raises, and time, for learning informatics skills. Other resources considered essential by at least one group were minimum data sets; consensus on ethical, legal, and privacy principles; and development of a business plan.

Discussion

Basic terms such as informatics were not defined for the Spring Congress attendees. Their inferred definitions spanned computer technology skills, informatics knowledge content, and even related knowledge such as business processes. Clearly, the attendees used a broad definition of informatics that spanned disciplines.

The methods for the conference were effective overall. The work-group method was useful for generating global ideas about the issues at hand, and the interdisciplinary nature of the work groups provided differing perspectives and provoked interesting discussions. The primary limitations of this method included the short time periods allotted for work. The 90-minute sessions did not allow groups to develop detailed strategies or needs statements to match the conference goals. Still, the work groups were enthusiastic about their responses and eagerly adopted this new method of functioning for an AMIA conference.

The Spring Congress attendees generated long lists of informatics educational needs, enough to make lifelong learning an absolute necessity, beginning in grade school. However, they thought that organizations should share the responsibility for teaching new skills and institute "just-in-time" learning. These lists of needs are not necessarily novel ideas, but they reinforce the fact that informatics education is a crucial tool for survival in contemporary health care settings. Most important, the non-informatics health professionals at this conference recognized the value of informatics.

The most striking observation about these needs and goals is their de-emphasis on technology, innovation diffusion, and other earlier concerns of informaticians. The issues of resistance to computers have seemingly vanished for participants in the Spring Congress. The work groups assumed that technology is as much an integrated tool of the practitioner as is the stethoscope. The concerns of these groups have evolved into how to optimize information systems in practice, how to tailor these tools in a personalized manner, how to more smoothly integrate tools into workflow and organizations, and how to design systems to permit critical information detection. Their identified skills blended business practices with informatics.

Several other themes were evident across the assigned tasks. First, groups acknowledged patients as being better informed, more assertive consumers. Practitioners now need tools for teaching patients how to evaluate the information they find, especially via the Internet, as well as tools for coping with practitioners' own changing roles as information interpreters. Second, groups identified general issues of privacy, security, and confidentiality; these were mentioned in every session by multiple groups. Another frequently mentioned issue was ethics—how to make ethical decisions in the digital age with new tools such as messaging technology.

Group members thought that informatics education still needed to focus on basic skills, but once these are mastered, higher level cognitive functions should be the emphasis of formal programs. That is, computers can do lower-level data processing, but information integration and critical thinking about information should be stressed during formal education. More important, the need for interdisciplinary competencies and teamwork resonated all three days. Teaching methods need to mirror the practice setting, complete with teams, team-building techniques, and less emphasis on independent decision making.

The groups thought that informatics education should be designed in the context of "real-world" applications and behaviors. This notion reflects Faughnan and Elson's concept[18] of "the knowledge landscape"; that is, informatics education should occur in the information environment where clinicians work, with consideration of the technologies that enable or modify this landscape. These authors also identified several key areas that educators should incorporate into the clinical curriculum—confidentiality, systems thinking, and knowledge-resource evaluation. These same issues were raised by the groups.

Many of the medical informatics objectives recommended by the AAMC[5] were reiterated by the various groups, including information retrieval strategies, information filtering and evaluation, and good "information habits," such as using multiple sources, making evidence-based decisions, and questioning the validity of sources. Confidentiality, security, and ethical issues mentioned by groups were also consistent

with medical informatics objectives of the AAMC. One distinguishing feature of the AAMC was their belief that computer literacy skills should be attained before medical informatics objectives are pursued. Our groups included computer skills as part of their educational needs and insisted that organizations allocate time for continuing education in health informatics.

Instructional strategies mentioned by the groups were similar to those recommended by the AAMC,[5] AACN,[1,2] and IMIA,[12] with the exception of mentoring. The groups thought that mentoring was a primary method for guiding learning about informatics. The groups also echoed the need for higher education to shift from a teaching to a learning paradigm, consistent with many authors' perceptions.[1,2,19–21] Learning paradigms are reflected in the groups' identified principles of active and exploratory learning strategies for knowledge acquisition; socially relevant, realistic, and intrinsically motivating problems to foster communication; collaboration; and feedback mechanisms.[22] The lack of equipment and monies are consistent with telecommunication, networking, software, and budget limitations identified by the MLA.

The thoughts from AMIA conference attendees provide the beginnings of a blueprint for informatics education in formal and continuing educational programs, for faculty and organizational leaders. The elements suggested here build on general recommendations in medical, nursing, and health sciences librarian guidelines, although more work is needed to add details to this beginning blueprint. In conclusion, conference attendees thought that the need for informatics education, especially for the non-informatics health professional, was obvious and the implied notion was to move as quickly as possible to effect their recommendations.

References ■

1. American Association of Colleges of Nursing. Essentials of baccalaureate education for professional nursing practice. Washington, D.C.: AACN, 1998:1–17.
2. American Association of Colleges of Nursing. A vision of baccalaureate and graduate nursing education: the next decade. Washington, D.C.: AACN, 1997:1–10.
3. Gassert CA. The challenge of meetings patients' needs with a national nursing informatics agenda. J Am Med Inform Assoc. 1998;5:263–8.
4. Recreating Health Professional Practice for a New Century: The Fourth Report of the Pew Health Professions Commission. San Francisco, Calif: Pew Health Professions Commission, 1998.
5. Association of American Medical Colleges. Medical Education Overview. 1999. AAMC Web site. Available at: http://www.aamc.org/meded/start.htm. Accessed Sep 7, 2000.
6. National Advisory Council on Nurse Education and Practice. A National Informatics Agenda for Nursing Education and Practice. U.S. Department of Health and Human Services, Health Resources and Services Administration. Washington, D.C.: GPO, Dec 1997.
7. Roper FW, Mayfield MK. Surveying knowledge and skills in the health sciences: results and implications. Bull Med Libr Assoc. 1993;81:396–407.
8. Dalrymple PW, Dahlen KH, Stoddart J. Imperatives for continuing research education: results of a Medical Library Association survey. Bull Med Libr Assoc. 1992;80:213–8.
9. Frisse ME, Braude RM, Florance V, Fuller S. Informatics and medical libraries: changing needs and changing roles. Acad Med. 1995;70:30–5.
10. Giuse NB, Huber JT, Kafantaris SR, et al. Preparing librarians to meet the challenges of today's health care environment. J Am Med Inform Assoc. 1997;4:57–67.
11. Giuse DA, Miller RA. Potholes in the road to professionalism in medical informatics [editorial]. Methods Inf Med. 1995;5:434–40.
12. International Medical Informatics Association. Recommendations on Education in Health and Medical Informatics [draft]. Nov 1999. IMIA Web site. Available at: http://www. imia.org/. Accessed Sep 7, 2000.
13. Espino JU, Levine MG. An overview of the medical informatics curriculum in medical schools. Proc AMIA Annu Symp. 1998:467.
14. Johnson JY. Curricular trends in accredited generic baccalaureate nursing programs across the United States. J Nurs Ed. 1995;34(2):53–60.
15. Carty B, Rosenfeld P. From computer technology to information technology: findings from a national study of nursing education. Comput Nurs. 1998;16(5):259–65.
16. Austin SI. Baccalaureate nursing faculty performance of nursing computer literacy skills and curriculum integration of these skills through teaching practice. J Nurs Educ. 1999;38(5):261–6.
17. Steane A, Rieffel E. Beyond bits: the future of quantum computing. Computer. 2000;33:23–9.
18. Faughnan JG, Elson R. Information technology and the clinical curriculum: some predictions and their implications for the class of 2003. Acad Med. 1998;73(7):766–9.
19. Dolence M, Norris D. Transforming Higher Education: A Vision for Learning in the 21st Century. Ann Arbor, Mich: Society for College and University Planning, 1995.
20. Denning PJ. How we will learn. In: PJ Denning PJ, Metcalfe RM (eds). Beyond Calculation: The Next Fifty Years of Computing. New York: Springer-Verlag, 1997.
21. Boettcher J. Twenty-first century teaching and learning patterns: What will we see? Syllabus. 1999;12(11):18–22. Available at http://www.syllabus.com/Jun99_magfea.html.
22. Skiba D. Transforming nursing education to celebrate learning. Nurs Health Care Perspect. 1997;18(3):124–9,148.