Adopting e-Learning Standards in Health Care: Competency-based Learning in the Medical Informatics Domain

William R. Hersh, MD, Ravi Teja Bhupatiraju, MBBS
Oregon Health & Science University, Portland, OR, USA
Peter S. Greene, MD, Valerie Smothers, MA, Cheryl Cohen, BA
Johns Hopkins School of Medicine and MedBiquitous Consortium, Baltimore, MD, USA

Like many forms of education, health professions education is increasingly competency-based. At the same time, there is growing use of e-learning technologies, which can be linked to competencies via emerging e-learning standards. Health care has been slow to adopt competencies and e-learning standards. We report our efforts to facilitate access to competencies and e-learning content in the medical informatics domain, linked by content-competency associations, based on standards developed by the MedBiquitous Consortium. We demonstrate that such standards can be successfully used and their implementation in other domains is warranted.

Among the many recommendations emanating from the Institute of Medicine *Crossing the Quality Chasm* initial [1] and follow-up reports are those advocating the improvement of health professional education [2]. One of the key changes occurring within health professions education is movement away from structure and process-based curricula to competency-based curricula that focus on the expected outcomes of the learning activity and the professional competencies learners are expected to attain. [3]. One set of competencies achieving broad use are the general competencies for residents specified by the Accreditation Council for Graduate Medical Education (ACGME) [4], which have been advocated as being necessary for tomorrow's practitioners to be able to deliver high-quality health care [5]. The ACGME competencies are driving change within residency programs, and programs are working to implement educational and assessment activities that address the competencies [6].

Implementing the competency-based paradigm can be a challenge. Many health professions educators advocate better use of educational technology, also known as e-learning, to educate and assess geographically dispersed and time-constrained physicians. Just as the adoption of electronic health records and their interoperability will be enhanced via adherence to emerging standards [7], implementation of effective e-learning may be enhanced by emerging standards for e-learning as well [8], both of which health care has been slow to adopt. The main sets of standards emanating from the e-learning community include:

- Advanced Distributed Learning (ADL) Sharable Content Object Reference Model (SCORM) - A suite of standards and specifications for online education that enables interoperability of learning content. SCORM implements a modular approach to online learning that aggregates discrete units of digital instruction called learning objects. Learning objects are self-contained and may be reused in multiple contexts and environments, including online courses, knowledge management systems, and performance support systems (http://www.adlnet.gov/scorm/index.cfm).
- Institute of Electrical and Electronics Engineers (IEEE) Learning Object Metadata (LOM) - Providing descriptive information about learning objects, LOM includes the title, author, description, keywords, educational objective, and other relevant information (http://ieeeltsc.org/wg12LOM/).
- IEEE Reusable Competency Definitions (RCD) Draft Standard for Learning Technology - defines a data model for describing, referencing, and exchanging competency definitions, primarily for online learning. Reusable Competency Definitions provide a way to represent the key characteristics of a competency and enable interoperability among learning systems that use competency information. The IEEE Learning Technology Standards Committee is currently working on the draft standard and examining the possibility of standardizing related standards, such as Simple Reusable Competency Map (http://ieeeltsc.org/wg20Comp/).
- Simple Reusable Competency Map - a proposed draft standard within the IEEE Learning Technology Standards Committee. The draft describes a data model for an aggregation of competency definitions and description of the relationships among those competencies in a directed acyclic graph. The data model enables organizations to describe and exchange competency data and uniquely identify and reference specific competencies [9].

The health care community is only beginning to make use of these standards. The standards organization taking the lead in adapting them to health care is MedBiquitous (www.medbiq.org), which is devoted to advancing healthcare education through technology standards that promote professional competence, collaboration, and improved patient care. MedBiquitous has the following projects to address the use of these standards for healthcare education:

- SCORM for Healthcare and Healthcare LOM - The SCORM technical framework and the LOM metadata standard provide a basic structure for describing and aggregating learning objects. These standards do not, however, address the special requirements for healthcare education, including credit information, off-label use disclosure, financial relationship disclosure, level of evidence, and medical terminologies. SCORM for Healthcare addresses these special requirements, extending the LOM standard and providing custom vocabularies for some metadata elements. This LOM profile is called Healthcare LOM. SCORM for Healthcare is simply a version of SCORM that implements Healthcare LOM. SCORM for Healthcare does not customize other parts of the SCORM framework, such as the SCORM Run-time Environment, Simple Sequencing and Navigation, and Content Packaging standards.
- Competencies - Competency and curricula standards are less well-developed. MedBiquitous has convened a working group to define healthcare requirements for competency definitions. The group will work with the IEEE Competency Data Standards working group.

We aim in this project to develop healthcare extensions to standards that emerge from the e-learning community. The competencies and curricula will be linked to learning objects that are described by SCORM and Healthcare LOM. The goal of the work described in this paper was to assess how well competencies and their linkage to e-learning content could be implemented in this framework. Unfortunately, beyond the ACGME competencies, there are few comprehensive collections of competencies for health care education generally. As such, we looked closer to home, namely the field of medical informatics, where a variety of competencies have been created by groups like the International Medical Informatics Association [10], the Association of American Medical Colleges [11], the United Kingdom National Health Service [12], and the Medical Research Council of Canada [13].

Methods

We began by attempting to identify competencies in medical informatics and content with which to link them. One readily available source of e-learning material available to us was the first author's 10x10 *Introduction to Biomedical Informatics* course, available on-line through a partnership of Oregon Health & Science University (OHSU) and the American Medical Informatics Association (AMIA) (http://www.amia.org/10x10/). This course, adopted from the introductory course in the biomedical informatics graduate program at OHSU, is designed to provide a comprehensive introduction for adult learners entering the informatics field. It has been very successful, with over 120 enrollees in the first year. We developed a smaller list of competencies tailored to the course material and designed to facilitate learners' understanding of the profession and discovery of resources targeted to a specific aspect of professional competence. After creating the list of competencies for the 10x10 course, we then implemented them in the RCD and Simple Reusable Competency Map emerging standards.

In order to be able to link the competencies to content, we then had to develop learning objects and associated Healthcare LOM records for the 10x10 content. The 10x10 course contains a variety of learning modalities, as shown in Table 1. The course consists of 12 units, the topics of which are shown in Table 2. Each unit is subdivided into 5-8 on-line voice over Powerpoint lectures of 20-30 minutes duration with associated slide handouts. The remaining content is based at the unit level, i.e., the reference handouts, reading assignments, discussion questions, and self-assessment quizzes are the level of the unit (not the individual lecture). An example of this is shown for Unit 3 in Table 3. We created Healthcare LOM records for each unit and lecture within each unit. The title field of each record was populated with the text of the titles from the respective unit or lecture. The description of the lecture field was populated with the text extracted from the Powerpoint file.

Results

As noted above, the goal of this work was to enable discovery of learning based on identified gaps in competency. To achieve this goal, it was necessary to develop competencies in the RCD framework and implement them in the MedBiquitous format. The competencies for the content of units 3-5 shown in Table 3 are listed in Table 4. An example of the RCD is shown in Figure 1.

Table 1 - Learning modalities for 10x10 units.

Teaching Modality	File format
Flash-based voice over Powerpoint lectures	.ZIP, launched from a .HTML page
Slide handouts	.PDF
Slide reference lists	.PDF
Reading assignments	.PDF or in a paper textbook
Discussion questions	.DOC
Multiple-choice self-assessment quiz	.DOC

Table 2 - Units of 10x10 course.

1. Overview of Discipline and Its History
2. Biomedical Computing
3. Electronic Health Records
4. Decision Support and Health Care Quality
5. Standards, Privacy and Security, Costs and Implementation
6. Evidence-Based Medicine and Medical Decision-Making
7. Information Retrieval & Digital Libraries
8. Bioinformatics
9. Imaging Informatics and Telemedicine
10. Other Informatics: Consumer Health, Public Health, and Nursing
11. Organizational Management in Informatics
12. Career and Professional Development

Table 3 - Details of Unit 3.

Content	Description	Objects (files)
3. Electronic Health Records	Unit level material: reference lists, discussion questions, self-assessment quiz	Unit 3.doc, Unit 3.enl
3. Electronic Health Records	Lecture 1 of 8 with presentation and slide handout	3.0.zip, 3.0.pdf
3.1 Clinical Data	Lecture 2 of 8 with presentation and slide handout	3.1.zip, 3.1.pdf
3.2 History and Perspective of the Health (Medical) Record	Lecture 3 of 8 with presentation and slide handout	3.2.zip, 3.2.pdf
3.3 Potential Benefits of the Electronic Health Record	Lecture 4 of 8 with presentation and slide handout	3.3.zip, 3.3.pdf
3.4 Definitions and Key Attributes of the EHR	Lecture 5 of 8 with presentation and slide handout	3.4.zip, 3.4.pdf
3.5 EHR Examples	Lecture 6 of 8 with presentation and slide handout	3.5.zip, 3.5.pdf
3.6 Current Status of the EHR	Lecture 7 of 8 with presentation and slide handout	3.6.zip, 3.6.pdf
3.7 Health Information Exchange	Lecture 8 of 8 with presentation and slide handout	3.7.zip, 3.7.pdf

Table 4 - Competency and linkage to content.

Competency	Content
Evaluate electronic health record systems based on their ability to meet the needs of a given clinical setting.	Unit 3 and sections 3.1-3.5
Recognize barriers to implementing electronic health records (EHRs) and formulate strategies to overcome those barriers.	Unit 3 and section 3.6
Formulate strategies to achieve health information exchange (HIE) and Regional Health Information Organizations (RHIOs) in one's community and what is necessary to achieve them.	Unit 3 and section 3.7

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Figure 1 - Competency definition.

In the process of development, we did find one shortcoming in the IEEE standard concerning the linkage of competency to content. In the standard, linkage is specified directly, i.e., there is a field in the LOM for linkage to the competency. We envision scenarios where this would be inadequate. For example, a developer of e-learning content may not be able to enumerate every possible competency for that particular content. We therefore decided it was necessary to create an intermediate data structure to link competencies to content (and vice versa) external to the content metadata. Figure 2 shows the Competency Association standard we developed that links competencies to content.

The next step in our work was to implement all of this in a usable system. After assessing various options, we selected the open-source eXist XML database (http://exist.sourceforge.net/) that would allow querying the data using the XQuery standard. Its application-programming interface (API) allowed us to develop a simple Web-basbed interface. The interface allows metadata records, competencies, or both to be retrieved by a search. Once a record or competency is chosen for display, the user can navigate across those linked by the Competency Associations.

Discussion

We developed and implemented competency-based learning standards in the medical informatics domain. Based on existing e-learning standards, there are no apparent reasons why this approach cannot extend to medical domains. Our next goal is to identify (or work with medical education organizations to create) learning competencies that can be linked to real on-line educational content. Discussions are currently underway with the American Academy of Family Physicians and other groups to develop such competencies and then identify on-line content for which LOM can be created and linked to those competencies.

We also aim to continue to develop our efforts in the medical informatics domain. Not only will we add more competencies and content to our collection, but we will also evaluate in order to enhance our approach. Our first step will involve performing usability studies on the interface to assess general user understanding of competencies and content. Because they come from the informatics field, we will use informatics graduate students from OHSU for initial usability testing.

Once the standards are mature for both the medical informatics and general medical domains, we will release the standard to the larger medical education community for wider adoption. Because MedBiquitous is an ANSI-accredited standards development organization, we will follow the MedBiquitous Standards development process, which is open, transparent, and consensus driven. The ultimate vision for our work is that health care professionals will identify competencies where they require learning and be able to query standards-based systems to identify content related to those competencies.

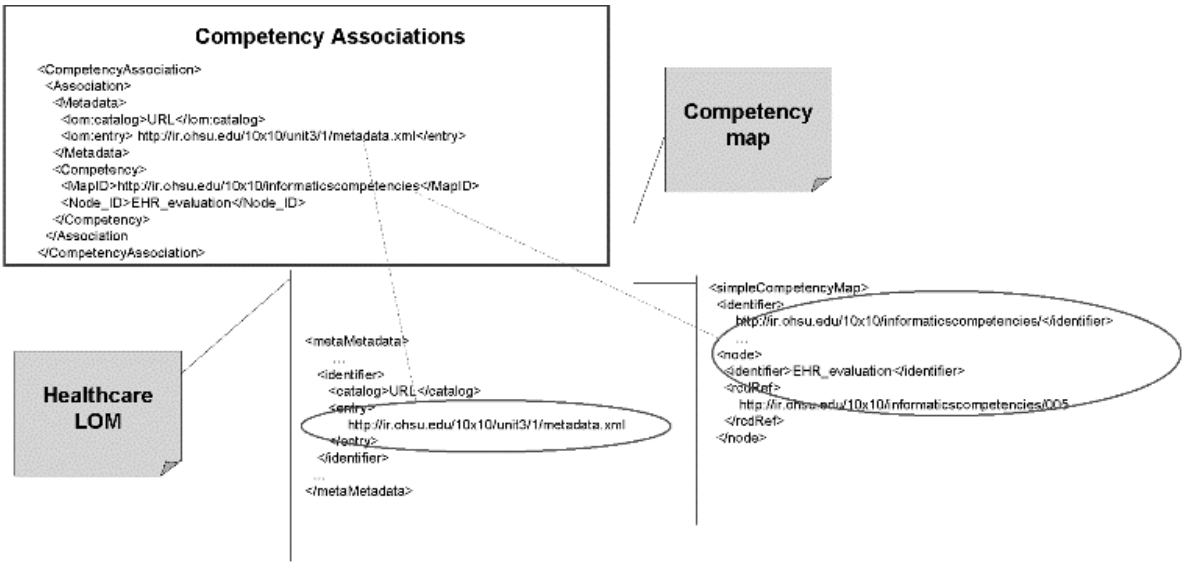

Figure 2 - Competency associations.

Acknowledgements

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References

1. Anonymous, *Crossing the Quality Chasm: A New Health System for the 21st Century*. 2001, Washington, DC: National Academy Press.
2. Greiner AC and Knebel E, eds. *Health Professions Education: A Bridge to Quality*. 2003, National Academy Press: Washington, DC.
3. Harden RM, *Learning outcomes and instructional objectives: is there a difference?* Medical Teacher, 2002. 24: 151-155.
4. Batalden P, Leach D, Swing S, Dreyfus H, and Dreyfus S, *General competencies and accreditation in graduate medical education.* Health Affairs, 2002. 21: 103-111.
5. Leach DC, *Changing educatoin to improve patient care.* Quality in Health Care, 2001. 10(Suppl II): ii54-ii58.
6. Brasel KJ, Bragg D, Simpson DE, and Weigelt JA, *Meeting the Accreditation Council for Graduate Medical Education competencies using established residency training program assessment tools.* American Journal of Surgery, 2004. 188: 9-12.
7. Hammond WE, *The making and adoption of health data standards.* Health Affairs, 2005. 24: 1205-1213.
8. Fallon C and Brown S, *E-Learning Standards: A Guide to Purchasing, Developing, and Deploying Standards-Conformant E-Learning*. 2002, Boca Raton, FL: CRC Press.
9. Ostyn C, *Proposed Draft Standard for Learning Technology - Simple Reusable Competency Map*. 2006, Ostyn Consulting: Kirkland, WA.
10. Anonymous, *Recommendations of the International Medical Informatics Association (IMIA) on education in health and medical informatics.* Methods of Information in Medicine, 2000. 39: 267-277.
11. Anonymous, *Medical School Objectives Project: Medical Informatics Objectives*. 1999, Association of American Medical Colleges: Washington, DC.
12. Anonymous, *Health Informatics Competency Profiles for the NHS*. 2001, National Health Service Information Authority: London, UK.
13. Covvey HD, Zitner D, and Bernstein R, *Pointing the Way: Competencies and Curricula in Health Informatics*. 2001.