Undergraduate Medical Instruction in
Clinical Informatics

Options for Online Learning Modules

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Background

Clinical Informatics

The ability of computers to extend human cognitive powers has led to their widespread use in health care. The proliferation of computers also has led to the emergence of disciplines that study the interface between computing and health care. A variety of terms are promoted for these fields: medical informatics, nursing informatics, clinical informatics, health informatics, bioinformatics, etc.; with varying emphasis on technology and theory.

A distinction can be made between conducting information science and applying information science in practice:

- **Health information science** is a basic science that generates new knowledge about the nature of health and clinical information problems, studies the storage, retrieval, and optimal use of biomedical data, information, and knowledge, and investigates the role of information in problem solving and decision making.

- **Health informatics** is an applied science that concerns itself with the uses and impact of health information on the cognitive, processing, and communication tasks of medical practice, education, and policy-making.

In this proposal, we use the term “**clinical informatics**” because it highlights the learning needs of students in the undergraduate medicine and dentistry programs. We de-emphasize technology, treating computational devices as tools that can facilitate effective information processes. This broader understanding also embraces important but often “orphaned” topics: clinical reasoning, clinical problem-solving, personal information management, clinical information systems, continuing professional development and evidence-based decision-making (EBDM).

The evidence-based decision-maker greets any source of information with questions about **validity** (is the information likely to be true?), **importance** (will the information make an important difference?) and **applicability** (can the information be used?). The “evidence-based” paradigm is, in fact, an information management construct. The usual placement of EBDM within epidemiology, community health or library science curricula fails to impress health science students with its relevance to patient care. Integrating EBDM with clinical informatics is a more natural fit, attracts clinically grounded instructors, and acknowledges the absolute dependence of EBDM on just-in-time knowledge.
Curricular Scope

We envision a coordinated, integrated and longitudinal program in clinical informatics spanning all four years of medical school. The curriculum will integrate a wide range of information “events” in a student’s pathway through undergraduate education.

The scope of the proposed Clinical Informatics curriculum includes important topics not currently taught at the University of Alberta. The proposed program also brings together fragmented topics currently divided among a variety of courses. These include:

**Information Communication Technologies**
- Asynchronous communication (email, discussions, etc.)
- Synchronous communication (telephony, conferencing, telehealth)
- Clinical Simulation

**Privacy, Confidentiality and Security**
- Consent to Information Release and Audit
- Privacy
- Confidentiality
- Security

**Personal Information Management**
- Safe Computing
- eClassroom Skills
- Personal Data Management
- Personal Digital Assistants
- Problem Based Learning
- Personal Learning Portfolios
- Continuing Professional Development

**Evidence-Based Decision-Making**
- Introduction to Evidence-Based Practice
- Assessing Health Problems
- Asking Questions
- Acquiring Evidence
- Appraising Evidence
- Applying Evidence

**Clinical Information Management**
- Electronic Medical Records
• Electronic Health Records
• Clinical Information Systems
• Coding and Classification
• Clinical Data Exchange

**Clinical Decision Support**

• Conceptual Framework
• Patient safety and medical errors
• Disease Guidance Systems
• Medico-legal Implications of Information Technologies
Curriculum

Overview

We propose to cover the following areas in a Clinical Informatics curriculum for students of medicine and dentistry. The curriculum is spread over all four years of training, and will approximate the sequence described below.

We have canvassed Canadian Medical schools to review how they address health informatics training and which topics work best with face-to-face versus online learning. Objectives and content of select American programs have also been reviewed. The proposed new Clinical Informatics curriculum also draws upon experiences teaching health informatics in the MSc Health Informatics program (UofA, UofC, UBC, UVic) and through the SEARCH (http://search.cche.net) and EXTRA (http://www.cche.net/extra) training programs.

Information Communication Technologies

Upon entering the Medicine and Dentistry programs, students are provided with a University computing identifier and password, giving access to University of Alberta network services (local area network, remote access and wireless access), electronic library services, electronic communication services (email and discussion group) and electronic learning services (mainly the webCT product).

Later, in third and fourth years, students are given additional instructions, user names and passwords for access to the Capital Health network, clinical information services, secure email services and clinical decision support Internet desktops.

The proposed clinical informatics curriculum will use these services to trigger learning events. Orientation to University information services in year 1, and to clinical information services in year 3, will be coupled with instruction about:

- **Email etiquette**
  - Appropriate email behaviors in learning environments
  - Norms for copying and forwarding email
  - Definitions of different levels of communication confidentiality

- **Information Communication Technology regulations**
  - Current regulations and penalties governing communications with identifiable patient information
  - Conventions and regulations pertaining to inter-professional
communications
Responsibilities for maintaining email archives

- **Internet Information Risk Management**
  Virtually all communication, learning and clinical information activities involve internet communications.
  Students learn the privacy, audit and risk exposures associated with various Internet zones, including Internets and virtual private networks. Students will know when and where they leave “electronic footprints” and who is able to view (officially and unofficially) what they are doing in different information zones.

- **Safe Computing**
  Basic orientation to how viruses, trojans, worms and exploits work. Dos and don’ts for safe personal and clinical computing.

- **Participating in Learning Communities**
  Highlights of what is known about sustaining effective virtual learning communities and strategies for creating and maintaining communities of practice. The latter is now a cornerstone of continuing professional development.

- **Clinical Simulation**
  Increasingly, the clinical skills curriculum uses electronic scenarios, multi-media demonstrations and clinical simulation technologies. This module helps the student to recognize these different types of learning tools and also to appreciate their unique benefits and weaknesses.

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**Privacy, Confidentiality and Security**

This module is about how security policies and protocols are used to protect privacy and enforce the confidentiality of health data. The first introduction to this topic occurs in connection with the first year information services module described above. Formal teaching of this module is started during link block (year 3) and continued online through year 3.

Students are oriented to the origins of present-day health privacy legislation before reviewing provisions of current Canadian and Alberta laws that will directly affect their interactions with patients. Electronic security techniques are categorized and illustrated. Emphasizing a pragmatic approach, students participate in activities where they devise ways of circumventing prevailing security protections… in order to better understand the importance of a culture of information security.

- **Consent to information release**
  Students are alerted to which elements of their personal information profile are available to which groups on and off campus, including release of academic performance information.

- **Information audits**
  Which student and clinician information behaviors are audited and which are not and why

- **Privacy**
  Conceptual framework for understanding the rights of patients to restrict access to personal information.
  Identification of major provincial and national privacy protection acts.
Clinical Informatics Curriculum Proposal

- **Confidentiality**
  Responsibilities of health institutions and practitioners to protect patient privacy.
  Distinctions between clinical, educational, research and programmatic uses of health information.
  How to recognize anonymized versus identifiable health information.

- **Security**
  Security techniques and technologies used in health care.
  Meaning of strong authentication.
  Introduction to basics of biometrics.
  Security methods used in Alberta and Canada.

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**Personal Information Management**

Today’s medical students learn in an electronic information space. All notes, texts, and clinical guides are available online and virtually all curricular activities are supported online. As it is impossible to ever know all that is important to know, students must become adept at just-in-time learning. This demands adoption of information skills completely different from those learned by their instructors when they were in training.

This module exposes students to techniques and tools that they may find helpful for managing their personal information spaces. In effect, students get exposed to principles of knowledge management and knowledge transfer – two very high priority areas of health services research – through teaching about practical tools that improve their ability to cope with the information overloads of medical training.

- **eClassroom Skills**
  Quick introduction to the use of WebCT and its integration with the Internet Virtual Learning Community for undergraduate training in medicine and dentistry.
  Introduction to other eLearning tools in use at the University of Alberta, including HistoQuest.
  Best practices when taking online examinations.

- **Personal Data Management Software**
  Exposure to the types of tools that can facilitate note-taking, coding and classification of individually acquired information.
  Types and merits of reference management software, with specific instruction in RefWorks (licensed by UofA).
  Information mapping software: creating concept maps as a learning strategy.
  Shared information tools: tools to facilitate collaborating through note-taking cooperatives.
  How to use the student’s Internet Desktop “My Workspace” to accrue a personal learning repository.

- **Personal Digital Assistants**
  Orientation to popular technologies for managing mobile personal information collections.
  Things to consider when purchasing a PDA.
  Classification of PDA software.

Continuing Professional Development activities are now mandated for all primary care and specialty groups. Students will learn about the most effective strategies for maintenance of competence, while gaining direct exposure to the sorts of online
tools that they will have to use, upon graduation, to participate in professional continuing education tracking programs. Since the University of Alberta has developed the practice reflection tools used by the CFPC and RCPSC, we have unique abilities to acclimatize students to professional information management before graduation.

- **Problem Based Learning**
  This module blends with the evidence-based decision-making module, but with emphasis on the practical application of the information cycle to problem based learning activities throughout the curriculum.

- **Knowledge Management**
  Knowledge management and knowledge transfer are the core priorities of a number of national health reform initiatives. Students will learn what knowledge management is, how it relates to knowledge transfer and how to understand the intent of new policies in these areas.

- **Personal Learning Portfolios**
  Upon graduation, students will be expected to maintain professional activity portfolios for residency training requirements and later for maintenance of certification in most clinical domains. The clinical informatics curriculum includes teaching students about how to use a personal learning portfolio which they start in first year problem based learning and will use regularly in third and forth years. The PLP including in the student’s internet desktop has the same format and structure used by the Royal College of Physicians and Surgeons of Canada.

- **Practice Reflection Projects**
  Students will use an adaptation of the ePEARLS practice reflection program of the College of Family Physicians of Canada to complete a minimum of two reflection projects in each of years 3 and 4.

- **Continuing Professional Development**
  What we know about what works in CPD.
  How students will be expected to document CPD when licensed.

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**Evidence-Based Decision-Making**

This is arguably the core training in clinical informatics because this module provides a conceptual framework for all other learning in the Clinical Informatics Curriculum. The structure of individual and group decision-making is explained. The Evidence-based Information Cycle (Assess, Ask, Acquire, Appraise, Apply) is defined and explicated, then used as the organizational framework for instruction in the following areas:

- **Introduction to Evidence-Based Practice**
  What is EBP and why has it become so prominent in the medical literature.
  Characteristics of evidence-based practitioners.
  Relationship to regional, provincial and national health reform.

- **Assessing Health Problems**
  How to extract clinically meaningful issues from patient and population health problem scenarios.
  Strategies for prioritizing issues for focus and attention.
Recognition and classification of health information needs. Alternative models of clinical reasoning: strengths and weaknesses

- **Asking Questions**
  - Distinction between background and foreground questions.
  - Anatomy of a well-built clinical question.
  - Mapping of questions to appropriate ways of knowing.
  - Taxonomy of question types.

- **Acquiring Evidence**
  - Classification of sources of evidence.
  - Differences between studies, synopses, summaries, syntheses and systems.
  - Clinical searching skills: in full-text search engines, indexed resources, standard-vocabulary dictionaries, bibliographic databases.
  - How to use clinical queries in national library of medicine databases.

- **Appraising Evidence**
  - Critical appraisal of the health sciences literature; focusing on appraisal of evidence about therapy, harm, prognosis, diagnosis and systematic reviews.
  - Critical appraisal of clinical advice found in consultant reports and other unpublished information sources.

- **Applying Evidence**
  - How to decide whether evidence can be used in individual and group decision-making.
  - Principles and options for translating evidence to support shared decision-making with patients.
  - Design and use of clinical practice guidelines.

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**Clinical Information Management**

With almost 100% of Alberta’s physicians using electronic medical records by 2010 (over 50% currently use EMRs), having a basic understanding of clinical information management has become essential for clinical practice. These learning modules will help students recognize different classes of health information systems, focusing on Clinical Information Systems, Electronic Medical Records and Electronic Health Records. The components of a medical record are explored as an example of the broader class of shared information tools. Improperly deployed, health information systems have the potential to harm patients. This module will equip students to look for attributes of systems that decrease errors of omission and facilitate improved patient care.

- **Student Electronic Medical Record**
  - The Centre for Health evidence will provide online access to a medical record “sandbox” for students to experiment with in conjunction with their problem-based learning sessions. A working copy of the prevailing Department of Medicine electronic medical record will be populated with the patient data associated with clinical scenarios from problem-based learning sessions.

- **Student Electronic Health Record**
  - Students will also be given access to the netCare training system, which is a fully functional version of Capital Health’s electronic medical record that does not contain live patient data. Assignments in this Clinical Informatics module will require students to find
information in both the student EMR and EHR, exposing them to functional differences.

- **Health Information Systems**
  Students will learn the different types of health information systems supporting Alberta’s health care system, including claims databases, health services database and clinical data repositories. The role of unique personal identifiers will be emphasized.

- **Coding and Classification of Clinical Information**
  Very basic introduction to the intent and uses of standardized medical vocabularies (e.g. Medical Subject Headings), coding systems (e.g. ICD-10, CPT, SnoMed) and messaging protocols (e.g., HL-7, CCOW). The simplest of database-design principles will be covered here.

- **Clinical Data Exchange and Telehealth**
  Basic principles and techniques for the asynchronous communication of clinical information events between health information systems. Introduction to the technologies and methods for synchronous communication and shared clinical encounters. Telehealth is explained, with emphasis on emerging Internet-based clinical communication tools that are less technology-dependent.

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**Clinical Decision Support**

This module is delivered in fourth year and nicely pulls together learnings from all previous modules. Clinical Decision Support systems link health observations with health knowledge to influence health choices by clinicians to improve health care. Consequently, this unit focuses on the interface between clinical information systems, evidence-based decision-making and information management. Students are exposed to a conceptual framework for CDS, then given rich hands-on experience with a wide range of clinical decision support tools.

- **Conceptual Framework**
  How to recognize the type of CDS students may find in a new clinical setting, and how to anticipate the strengths and weaknesses of each type of CDS.

- **Patient Safety and Medical Errors**
  Errors of omission and commission and how they occur in health systems; with an emphasis on how sound informational practices could improve the quality and safety of patient care.

- **Disease Guidance Systems**
  These are becoming ubiquitous in the clinical workplace and students need to know when they are dealing with passive, active or directive disease guidance. Students learn through experience how to work with caremaps, physician order entry systems, etc.

- **Medico-legal Implications**
  The “standard of care” that students will be expected to meet now includes ready access to decision-support. This has liability implications that students can best explore in online forums.
Practicum

Overview

The proposed Clinical Informatics curriculum lists topics that will be covered over a 4 year period. The topics will not be taught using conventional teaching techniques, as explained in the section on Pedagogy. To help build a virtual learning community among the medicine and dentistry students, and to enable experiential learning, the Clinical Informatics curriculum will provide students with a number of informational resources and experiences. These will include the following, all delivered and integrated through a secure Internet Desktop that will facilitate the kind of encryption, audits and strong authentication that must be present for students to be exposed to clinical information systems.

All of the following assets currently exist.

Internet Desktop

The University of Alberta has developed a secure, single-signon, Internet information environment that has been adopted by health organizations world-wide. Currently, this desktop technology underpins the College of Family Physicians of Canada electronic continuing professional development program, the Royal College of Physicians and Surgeons eLearning Program, the American Medical Association evidence-based learning initiative, etc. Most importantly, the desktop is used within Capital Health to couple clinical information systems with communication tools and clinical decision support. Students will use “CHEDESK” in their clinical years and so are helped by becoming acclimatized from the start of their medical training.

This curriculum will be delivered through an adaptation of the Users Guides Interactive (http://www.usersguides.org) desktop, an Undergraduate eLearning environment funded by the American Medical Association, and CHEDESK, a clinical practice environment used in Edmonton.

In order for the Clinical Informatics desktop to become a vibrant online learning community, we propose to take advantage of all its single-sign-on capabilities. These are all already tested, approved and in place at the University of Alberta and all Capital Health teaching and practice facilities. Through this curriculum, all students will enjoy these integrated information services from day 1:

- University Library Services
  With the University’s proxy systems built in, the desktop gives single-
sign-on access to all library eTexts, journals, and information resources irrespective of whether the student logs on at home, hospital or University.

- University email
- Clinical email (secured and encrypted)
- Personal Learning Portfolio
- WebCT, HistoQuest and other eClassroom tools
- Physical Examination Clinical Skills videos, simulations and instruction
- All clinical rotation objectives and student manuals
- webEval electronic student evaluation system
- RefWorks Citation management system
- Users Guides Interactive (evidence-based decision-making)
- Rational Clinical Examination online learning resources
- Discussion forums
- Personal workspace
- Personal notes
- Practice Reflection Projects
- Electronic Health Record “Sandbox”
- Clinical Decision Support “Sandbox”
- Clinical information systems (years 3 and 4)
- Patient Tracker

The desktop was pilot tested in 2003 and 2004 with good results and is presently in use by 3rd and 4th year students.

The desktop technology has the ability to monitor participant information behaviors. This is a powerful research tool but will be used here primarily to confirm student participation in the Clinical Informatics curriculum.

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**eClassroom**

All existing electronic learning tools, including webCT and Histoquest, are used and are also the subject of instruction in the Clinical Informatics Curriculum. The curriculum support staff will work closely with other groups on campus to ensure that current University of Alberta eLearning tools are integrated in the best possible way. As at present, these same tools will always be available outside the Clinical Informatics desktop and the CI slides, handouts and tutorials will be made available within webCT.

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**Electronic Health Record Sandbox**

In collaboration with Capital Health, students will be given access to a training “netCare” application. This functions in all ways like the electronic health record
used to access laboratory test results, microbiology results and radiology reports
everywhere in Alberta. The “Sandbox” will not have live patient data. However, it
will be populated with “dummy” records that will be linked to the student’s problem
based learning exercises.

Electronic Medical Record Sandbox

A number of University specialty and primary care physician groups have adopted
Electronic Medical Records. Currently we have permission from the most prevalent
of these (HealthQuest) to set up a demonstration EMR, made available through the
Clinical Informatics Desktop, for medical students. Again, this EMR will be
populated with fictitious data in support of problem based learning exercises. Over
the years, we may add alternative EMR products.

Personal Learning Portfolio

The University of Alberta, in collaboration with the University of Ottawa, is
developing and testing a personal learning portfolio for resident training programs in
Canada, to be released first quarter 2006. We propose to adapt this online product
for medical student use. It allows students to track their clinical learnings and patient
care activities. Another UofA informatics initiative is developing and deploying a
clinical skills diary, which will be integrated with the PLP.

Personal Reflection Project

The University of Alberta has developed electronic practice reflection exercises for
both the CFPC and RCPSC. These are used to award MAINPRO type C credits. The
system is adapted for medical student use through the Users Guides Interactive
initiative and will be used to support instruction in evidence-based practice.
Pedagogy

Experiential Learning

Each module of the Clinical Informatics curriculum is buttressed with working examples of relevant software, or working tools that students can use to fulfill the learning objectives. We propose to “practice what we preach”, avoiding conventional lectures, note-taking, and examinations. Instead, the entire curriculum will be available online at all times, allowing students to progress at their own pace. “Instructors” will be drawn from clinically grounded faculty, librarians and health informaticians who will take turns participating in online discussion, help and student feedback venues.

The Clinical Informatics curriculum will be divided into multiple learning modules, much along the lines of the topic groups described above. Students will be encouraged to follow the modules sequentially, or at least to defer learning about clinical information systems to third year. All learning objectives are carefully defined online.

Lectures

All lectures that are important for achieving learning objectives are provided online in both shockwave and powerpoint formats. Most lectures already exist but many will need to be adjusted to the undergraduate student level.

A number of curriculum hours will be requested for face-to-face (live) lectures. These will emphasize topics best introduced this way and will only be offered by instructors with demonstrated large-group teaching skills. Examples of lecture topics include:

- Introduction to Evidence-Based Practice
- Evidence-Based Information Cycle
- Patient Safety and Medical Error
- Privacy, Confidentiality and Security
**Information Clinics**

By de-emphasizing lectures and expecting students to learn continuously and experientially, we hope to free up sufficient schedule time to support a series of optional “information clinics”. These will be open question-answer-demonstration sessions where students can bring issues and ideas for exploration with a health informatician. Hot topics in online discussion areas will also be featured. Students can see how busy clinicians find answers to clinically important questions. In year 1, a number of drop-in computer lab sessions will be used to ensure that all students tool-up and skill-up to participate in the virtual learning community.

**Evaluation**

We propose to experiment with new approaches to evaluation. Although conventional examination questions will be set, and added to existing undergraduate medical examinations, the Clinical Informatics curriculum will give equal or greater weight to:

- Online discussion forum participation
- Completion of online “interactivities”
- Weighted time spent exploring various clinical information tools
- Assessment of one Personal Reflection Project in 4th year
- Maintenance of Personal Learning Profile
- OSCE “information” stations (e.g. demonstrate how you would seek information in answer to a set question)

Some concepts in clinical informatics, particularly those in the evidence-based decision-making module, are particularly important for certification (LMCC) purposes. Through the virtual learning community, we have the ability to randomly assign single questions at any time and propose to experiment with this technique in 4th year.
Implementation

Overview

What we propose may be perceived as revolutionary. Certainly, we advise a radical departure from how these topics have been addressed in the past; to the extent that they have been addressed at all. However, the approach we propose is not likely to adversely affect current classroom hour allocations. Indeed, it is possible that de-fragmentation of instruction in clinical informatics could even free up time. We hope so, as that time would be better allocated to non-lecture learning time.

Whether we can win agreement with the proposed approach or not, it may still be impossible to mount such an ambitious program. There are currently a number of “stakeholders” who “own” some of these topics within specific courses. Shifting to a different organizational paradigm could be perceived as expecting too much additional effort.

Existing Assets

The good news is that the University of Alberta has most of the required online curriculum already at hand; this by virtue of UofA faculty’s contributions to other forms of clinical informatics instruction.

Users Guides Interactive

Users Guides Interactive, developed at the UofA and available to UofA students royalty-free, has a medical student curriculum ready-made. This would be trimmed back to meet the evidence-based decision-making objectives of the clinical informatics curriculum. UGI has developed and extensively tested the required online lectures, activities, discussion areas, examinations, interactive tools and critical appraisal activities.

SEARCH Informatics Curriculum

A number of the topics in the proposed Clinical Informatics Curriculum have already been developed and tested for online instruction through Alberta’s SEARCH training program, targeted at health professionals in the workplace. Modules like privacy, confidentiality and security already have readings assembled, lectures developed, and exercises in place. As a SEARCH partner, the UofA can make use of these curricular modules royalty-free.
**Personal Reflection Project, Personal Learning Portfolio**

Both of these technologies are developed by the UofA Centre for Health Evidence for health professional organizations and so can be relatively easily adapted for medical student use.

**Clinical Information Systems and Decision Support**

The UofA has helped to guide the development of these systems and already provides decision support integration services to Capital Health. Therefore, the requisite internet technologies are in place an tested and ready to go. Proposed CI instructors are on the clinical advisory groups for Capital Health and are positioned to facilitate deployment of the clinical information “sandboxes” for students.

**eClassroom**

The UofA already has the requisite eLearning tools in place, tested, and integrated with the proposed Clinical Informatics desktop.

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**Human Resources**

Our greatest difficulty will be securing sufficient time from busy instructors and clinicians to enliven the curriculum. We propose to re-align already committed University of Alberta Librarians (currently teaching literature searching), clinical epidemiologists (currently teaching evidence-based practice) and link block instructors (currently teaching privacy and confidentiality).

In addition, we propose to rally the clinical informaticians to contribute smaller amounts of time to this curriculum, participating in online discussions and occasional lectures. There are a number of excellent teachers who both know about the proposed curricular topics and are able to share exciting clinical experiences with students.

Currently, there are but a few trained health informaticians and they would need to focus on curriculum design and deployment.

A great deal of organizational, administrative and desktop integration work must occur to get this curriculum started. This cannot happen without significant startup funds.

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**Technical Dependencies**

We are aware of no technical reason why we cannot do what is proposed here. All requisite technologies are approved and tested in our venue and all have been used by some students already. The Internet desktop technology can be used royalty-free, allowing resources to be allocated exclusively to the staff time needed to mount the proposed curriculum.

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**Curricular Dependencies**

TBD