Australian Health Informatics Educational Framework

Dr Sebastian Garde, Prof. Evelyn Hovenga,
Faculty of Informatics and Communication, Central Queensland University, Rockhampton

Health Professionals increasingly need to use Information Technology (IT), and some also deploy, research or develop health care IT. Consequently, they need to be adequately educated for *their* roles in Health Informatics (HI). A myriad of different opportunities exist in Australia for obtaining an education in Health Informatics. This education can start with an Information Technology or Information Systems Bachelor's degree with or without a specialization in HI, or with any health professional degree followed by HI education in the form of continuing professional development, or by undertaking a certificate, diploma or degree program in HI. To date we have seen engineers, mathematicians, physicists, librarians, medical record administrators, computer scientists and others become experts in HI. The HI discipline is broad and varied. Health Informatics education providers need to remain relevant and current in the content and delivery of Health Informatics education and training.

The aim of this Australian Health Informatics Educational Framework is to provide guidance with regard to 'good' Health Informatics education while acknowledging

- the diversity of different roles in Health Informatics,
- the diversity of ways that lead to Health Informatics and
- the diversity of education within the Health Informatics discipline

This diversity is fruitful and needed, however, in the process of providing national guidance on health informatics education ([1], [2]), a common understanding of educational outcomes is required. An *Educational Framework for Health Informatics Professionals* as proposed by Hovenga [3] can provide clarity about the relative position of different qualifications. It can provide guidance for educational providers in developing and updating Health Informatics educational programs and support the administration of credit-transfers to support the recognition of prior learning.

NB: This framework does *not* intend to establish an accreditation process for Health Informatics education in Australia. If accreditation is desired it can be based on the *guidance* this educational framework provides.

Material, Methods and Background Information

This educational framework was developed using the following material and methods:

- **IMIA's endorsed set of recommendations on education** in Health and Medical Informatics from 1999 [4]. The recommendations include topic areas to be covered within each of three knowledge/skill domains and indicate the level of knowledge required in terms of 'introductory', 'intermediate' or 'advanced'.
- **IMIA's scientific map** (http://www.imia.org/endorsed.html).
- Recent research to **analyse the various roles and functions** of health informaticians and to develop associated competencies [5-8] and a major **workforce research study** [9] regarding skill sets for health information management. In these studies, usually a 'roles-based' approach was employed to identify required competencies for each role.
- A **survey** of academic and industry professionals regarding the preferred skill set of graduates of medical informatics programs that was conducted in the USA by Hoffmann and Ash [10].
- the internationally recognized **degrees of competencies** as introduced by Benner [11]: *Novice*, *Advanced Beginner*, *Competent*, *Proficient*, and *Expert.*
- A **survey of Australian Health Professionals** regarding the required degrees of competencies for a total of 69 skills to succeed in various Health Informatics roles [12] to directly inform an Australian Health Informatics educational framework and prepare the basis for a more detailed international educational framework.
- **Bloom's Taxonomy**: Bloom, an educational psychologist, developed a classification of levels of intellectual behaviour [13]. The classification featured the following levels of intellectual behaviour:
  1. knowledge (the lowest level, pure recall of data),
  2. comprehension (understand the meaning) ,
  3. application (use a concept in a new situation),
  4. analysis (identify components, see patterns),
  5. synthesis (put parts together to form a new whole),
  6. evaluation (the highest level, make judgments about the value of ideas or materials)

Collectively, these works provided a sound foundation for the development of the Australian Health Informatics Educational Framework.

Benner's Degrees of Competency and Bloom's Taxonomy

For the framework, the internationally recognized degrees of competencies as introduced by Benner [11] are used: *Novice*, *Advanced Beginner*, *Competent*, *Proficient*, and *Expert*. The degrees are in the following given values from 1 (*Novice*) to 5 (*Expert*). The degree of competency can be understood as the *depth* of expertise/understanding required in one field.

No education is required to gain an understanding at *Novice* level, maximum education and experience is required to become an *Expert*.

Both the minimum (core) degrees of competency required as well as the maximum degrees of competency required for each skill are mentioned in this framework. The maximum degree does not include a specialisation in this field in which case an expert degree of competency can be expected for each skill.

Figure 1 shows how Bloom's Taxonomy and Benner's Degrees of Competency relate. For example, *novices* have limited *knowledge* and very limited *comprehension* of the field and need to be initially educated to expand knowledge and comprehension.

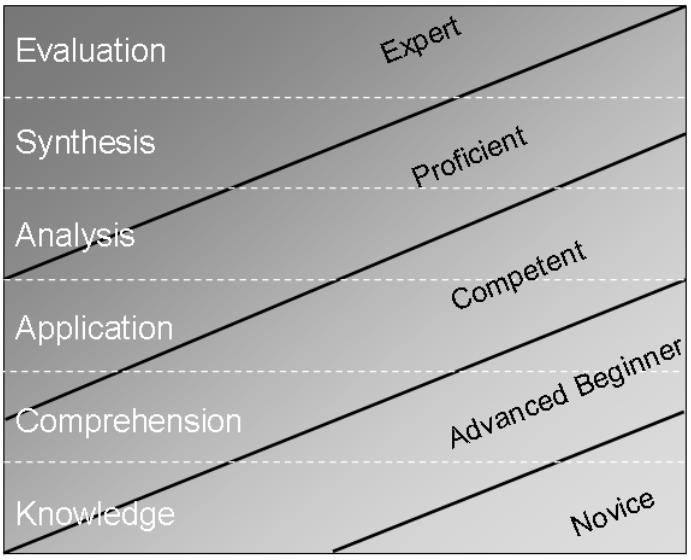


Figure 1: Comparison between Bloom's Taxonomy (white text and lines) on the left and Benner's degrees of competency (black font and lines) on the right.

Breadth and Complexity of a field

Apart from the degree of competency required for the 'ideal' Health Informatician in a specific role, the breadth of the field is important to determine the amount of education required. Also, the complexity of a field has to be taken into account. For example, it can be argued that for "change management"

- the knowledge/skills that are important for Health Informaticians to possess regarding the deployment of Information technology in Health Care need to be at the *proficient* level as a minimum.
- is not a very broad field (as compared e.g. with Mathematics)
- is however a rather complex field.

Degree of Competency, Breadth and Complexity together define the amount of education required for this field.
Based on these three variables (of which two, breadth and complexity, are fixed for one field), the amount of education required can principally be calculated to determine the credit points required to achieve the desired educational outcome.
This framework will detail the Degrees of Competency for each field, but will not detail the Breadth and Complexity of each field.

Standardised credits

As there is no standardised credit system available in Australia, for the purpose of this framework we will employ the European Credit Transfer System (ECTS, http://europa.eu.int/comm/education/programmes/socrates/ects_en.html). ECTS defines the yearly workload for full-time students as equivalent to 60 credits. The student workload of a full-time study programme in Europe amounts in most cases to around 1500-1800 hours per year and in those cases one credit stands for around 25 to 30 working hours. Student workload in ECTS consists of the time required to complete all planned learning activities such as attending lectures, seminars, independent and private study, preparation of projects, examinations, and so forth.

Knowledge/Skills categories

The body of knowledge consists of 5 knowledge/skills categories relevant to Health Informatics:

- specific health informatics knowledge/skills;
- information technology knowledge/skills;
- people and organisational knowledge/skills;
- clinical, medical and related knowledge/skills; and
- various knowledge/skills.

Roles in Health Informatics

Similar to the Canadian competencies and curricula in Health Informatics report [8] we define three primary roles persons can take on in Health Informatics: They can primarily be

- *users* of IT and knowledge resources in health care;
- *deployers* of IT and knowledge resources in health care; or
- *researchers* and/or *developers* of IT and knowledge resources in health care.

A typical example for *users* are clinicians who need to use a computer on a regular basis. They need to understand the general concepts of computer use and how the use of information and communication technologies (ICT) can best support their practice.

A typical example for *deployers* are Information Technology professionals who deploy application systems in a hospital. They need to be IT-savvy but they only need to understand the bigger picture of Health Information Systems and the business of health care delivery.

A typical example for *researchers and developers* are conceivers and developers of new Health Informatics ideas, Chief Information Officers (CIOs), Information architects and in the sense of evolving agile programming methods also software developers/engineers.

NB: It is important to mention that all these roles contain a myriad of more specialised roles which essentially all require different skills. Especially depending on the focus of ICT versus knowledge resources, the required skills may vary.

Health Informatics Body of Knowledge

Specific Health Informatics Knowledge/Skills

Knowledge/Skill	Min/Max Degree of Competency required		
	HI Users	HI Deployers	HI Researchers & Developers
Health Information Systems (General Characteristics, Architecture)	2-3	2-3	3-4
Management of Health Information Systems	2	3	3-4
Health Data, Information & Knowledge Management	2-3	3	3-4
Health Concept Representation	1-2	2	2-3
E-Health/ Telehealth/Telemedicine	2	3-4	3-4
Coding & Classification (ICD, DRG etc.)	2-4	2-4	2-3
Health Informatics Standards (HL7 etc)	1-2	2-4	3-4
Decision Support Systems/ Knowledge Based Systems/ Expert Systems	1-2	1-2	2-4
Bioinformatics	1-2	1-2	2-3
Epidemiology	2	1-2	2-3
Biometry	2-3	1-2	2-3
Outcome Measurement/ Practice Evaluation	2-3	1-2	2-3
Health Care Organisation & Administration	2	2-3	2-3
Electronic Patient Records/ Electronic Health Records	2-3	2-3	3-4
Artificial Intelligence in Medicine	1-2	1-2	2-3
Organ Imaging Informatics	1	1	2-3
Medical Signal Processing	1	1	2-3
Technology of Measurement & Electrical Engineering	1	1-2	1-2
Mathematical Models in Medicine/ Biomedical Modelling	1	1	2
Medical Robotics	1	1	1-2

Computing Knowledge/Skills

Knowledge/Skill	Min/Max Degree of Competency required		
	HI Users	HI Deployers	HI Researchers & Developers
Programming Principles	1-2	3-4	3-4
Programming Languages	1-2	3-4	3-4
Software Development Methodologies & Processes	1-2	3-3	3-4
Algorithms & Data Structures	1	3-4	3-4
Operating Systems & Administration	1-2	2-4	1-2
Theoretical Informatics	1	2	2
Technical Informatics	1	2-3	2-3
Business Analysis/ Workflow Analysis	1	3	3
Systems Analysis/ User Requirements Identification	1-2	2-3	3-4
Systems Design/ Technical Requirements Specification	1-2	2-3	3-4
Systems Test	1-2	3-4	2-3
Modelling (Objects, Processes; UML)	2	2-3	2-3
Database Management	1	3-4	2-3
Database Design	1	2-3	3-4
Database Querying	1	2-3	2-3
Database Protection & Security	1-2	3-4	2-3
Graphical Data Processing	1	1-2	1-3
Real Time Data Processing	1	1-3	1-3
System Programming	1	2-3	1-2
Network & other Protocols	1	2-3	1-3
Speech Recognition	1	1-2	1-2
Distributed Systems	1	2-4	2-3
User Interface Design	2	2-3	3-4

People & Organisational Knowledge/Skills

Knowledge/Skill	Min/Max Degree of Competency required		
	HI Users	HI Deployers	HI Researchers & Developers
Project Management	1-2	3	3-4
Change Management	1-2	3	3-4
Quality & Safety Management	2	2	3-4
Risk Management	2	2	2-4
Social Competency	3-4	3-4	3-4
Effective Communication between Health & IT Professionals	3-4	3-4	3-4
Expressing complex clinical Knowledge in plain English	3-4	1	1

Clinical & related Knowledge/Skills

Knowledge/Skill			
	HI Users	HI Deployers	HI Researchers & Developers
Anatomy	3-4	2-3	2-3
Physiology	3-4	2	2
Pathology	3-4	2	2
Biochemistry	2-3	1	1-2
Genomics	1-2	1	1-2
Clinical Disciplines (Internal Medicine, Surgery, ...)	3-4	2	2
Evidence-based Practice	3-4	2-3	2-3
Clinical Trials	2-3	2-3	2-3
Clinical Guidelines	2-3	2-3	2-3
Diagnostic & Therapeutic Strategies	3-4	2-3	2-3

Various Knowledge/Skills

Knowledge/Skill	Min/Max Degree of Competency required		
	HI Users	HI Deployers	HI Researchers & Developers
Business Management	1-2	1-2	2
Economics	1-2	1-2	2
Legal Understanding	2	2-3	2
Social Science	1-2	1-2	2-3
Ethics	3-4	2	2-3
Medical Physics	1-2	1	1-2
Mathematics	1	2	2-3
Statistics	2-3	2	2-4
Cryptology/ Cryptography	1-2	3	2-3

Curriculum Design Recommendations

Figure 2 shows the emphasis on knowledge intake, utilisation, and generation for Bachelor, Master, and PhD degrees and their relation to Bloom's Taxonomy for many disciplines.

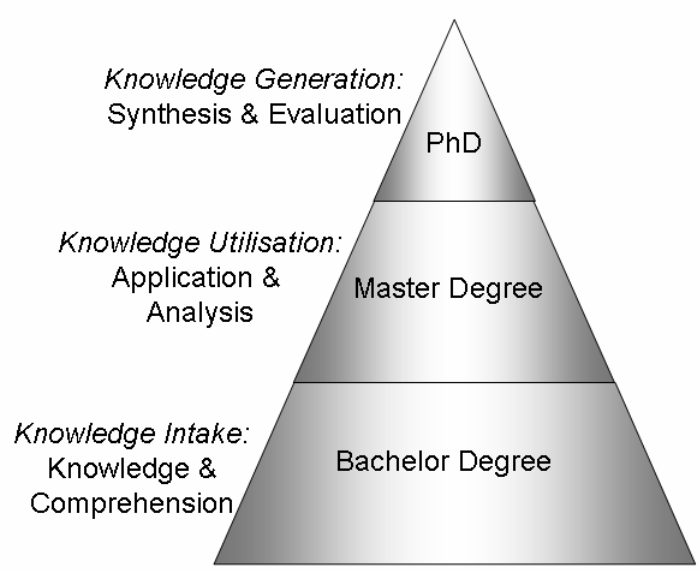


Figure 2: Knowledge Intake, Utilisation and Generation, their relation to the levels of Bloom's Taxonomy and Bachelor, Master and PhD degrees. The emphasis for Bachelor programs is on Knowledge Intake, the emphasis for Master programs is on Knowledge utilisation, and the emphasis for PhD programs is on knowledge generation.

However, this simple separation is not sufficient for the discipline of Health Informatics for the following reasons:

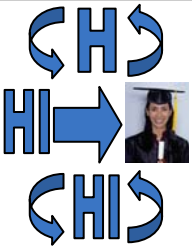
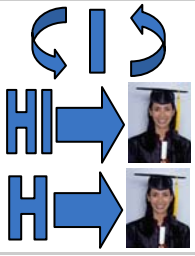
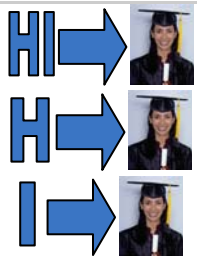
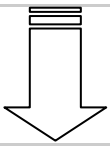
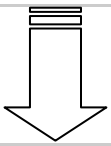
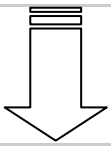
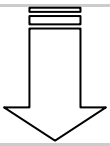
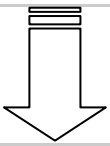
- Health Informatics as a discipline is very specialised, complex, broad and versatile.
- Many different pathways can lead to a career as a Health Informatics Professional
- Possible education for Health Informatics Professional can be based on Health degrees, Informatics programs, and/or dedicated Health Informatics programs.

In the following we therefore differentiate between (i) Knowledge Intake, (i) Knowledge Utilisation and (iii) Knowledge Generation in (a) Health, (b) Informatics and (c) Health Informatics (Table 1). Table 2 provides an overview of different educational pathways to Health Informatics and what kind of knowledge intake, utilisation and generation is required for the fields.

Table 1: Symbols for Knowledge Intake, Utilisation and Generation in Health, Informatics and Health Informatics

	Health	Informatics	Health Informatics
Knowledge Generation			
Knowledge Utilisation			
Knowledge Intake			

Table 2: Possible Pathways to Health Informatics. The required knowledge intake, utilisation and generation are specified for Health, Informatics, and Health Informatics knowledge. Possible resulting roles of each educational pathway are also stated.

	Dedicated HI program	Within clinical degrees	In addition to clinical degrees	In addition to Informatics degrees		Continued HI education for Health Professionals
PhD						
Master						
Bachelor						
						
	Deployer Researcher/ Developer	***User***	***Deployer User***	***Deployer Researcher/ Developer***		***User***

Recommendations for Dedicated Educational Programs in Health Informatics

Within dedicated educational programs for Health Informatics, 5 years of full time study are recommended consisting of a Bachelor and Master Degree.

Bachelor of Health Informatics

Knowledge/Skill Category	**ECTS Credits**
Specific Health Informatics	55
Computing	55
People & Organisational	25
Clinical & related	25
Various	20
SUM	**180 (3 yrs)**

Master of Health Informatics

Knowledge/Skill Category	**ECTS Credits**
Specific Health Informatics	35
Computing	35
People & Organisational	20
Clinical & related	15
Various	15
SUM	**120 (2 yrs)**

Recommendations for Health Informatics Education within *all* Clinical Degrees

It is recommended to integrate Health Informatics education as tightly as possible into clinical curricula (e.g. by using simulated health information systems for teaching) and in addition have a selection of Health Informatics courses, focusing on general IT skills as well as Information processing principles, mediate the complexity of Health Informatics and focus on those skills rendered most important for IT Users in Health Care (e.g. effective communication).

Knowledge/Skill Category	**ECTS Credits**
Specific Health Informatics	10
Computing	5
People & Organisational	5
Clinical & related	0
Various	5
SUM	**25 (<0.5 yrs)**

Recommendations for Health Informatics Education in addition to Clinical Degrees

In addition it is valuable to have dedicated degrees for Health Informatics Professionals in addition to a clinical degree focusing on Health Informatics. At least 1 year full time study in addition to the core clinical education is required.

Knowledge/Skill Category	**ECTS Credits**
Specific Health Informatics	15
Computing	25
People & Organisational	10
Clinical & related	5
Various	5
SUM	**60 (1 yr)**

Recommendations for Health Informatics Education within Information Technology, Information Systems and similar degrees

At least one year full time study in addition to the core knowledge and skills of the IT/IS degree which can be in specialisation streams of the IT/IS degrees. For example a Bachelor of Information Systems (Health Informatics) could consist of 120 Credits pure IT/IS and 60 credits Specific Health Informatics skills.

Knowledge/Skill Category	**ECTS Credits**
Specific Health Informatics	25
Computing	5
People & Organisational	10
Clinical & related	15
Various	5
SUM	**60 (1yr)**

Recommendations for continued Health Informatics Education for Health Professionals

At least the equivalent to 0.5 years full-time study is recommended for continued Health Informatics education for Health Professionals.

Knowledge/Skill Category	**ECTS Credits**
Specific Health Informatics	15
Computing	5
People & Organisational	5
Clinical & related	0
Various	5
SUM	**30 (0.5 yrs)**

References

1. Hovenga EJS, Mantas J, eds. 2004 Global Health Informatics Education. Stud Health Technol Inform. IOS Press, Amsterdam.
2. Hovenga EJS (2003) Globalisation of Health and Medical Informatics Education – what are the issues? IMIA Working Group on Education Conference, Portland, Oregon, USA, April 2003.
3. Hovenga EJS (2004): A Health Informatics Educational Framework. In: Hovenga EJS and Mantas J, Eds. Global Health Informatics Education. Amsterdam: IOS Press.
4. Haux R, Grant A, Hasman A, Hovenga E, Knaup P (2000) Recommendations of the International Medical Informatics Association (IMIA) on education in health and medical informatics. Methods Inf Med 39: 267-77.
5. Saba V, Skiba DJ, Bickford C (2004): Competencies and Credentialing: Nursing Informatics. In: Hovenga E and Mantas J, Eds. Global Health Informatics Education. Amsterdam: IOS.
6. NHS Information Authority (2002) Health Informatics Skills and Competencies: A framework to support NSF implementation.
7. Canadian Nursing Informatics Association (2003) Educating Tomorrow's Nurses: Where's Nursing Informatics? OHIH Research Project: 2002-2003 Final Report.
8. Covvey HD, Zitner D, Bernstein RM (2001) Pointing the Way: Competencies and Curricula in Health Informatics (Essay). The Informatics Review.
9. Wing P, Langelier M, Continelli T, Armstrong D (2003). Data for decisions: The HIM Workforce and Workplace 2002 Member Survey, American Health Information Management Association.
10. Hoffmann S, Ash J (2001) A survey of academic and industry professionals regarding the preferred skillset of graduates of medical informatics programs. Medinfo 10 (Pt 2): 1028-32.
11. Benner P (1984) From novice to expert: Excellence and power in clinical nursing practice. Addison-Wesley, Menlo Park.
12. Garde S, Harrison D, Hovenga E (2005) Skill Needs for Nurses in their Role as Health Informatics Professionals: A Survey in the context of Global Health Informatics Education. Accepted for publication in Int J Med Inf.
13. Bloom BS, ed. 1956 Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain. Longmans, Green, New York ; Toronto.