IFIP/UNESCO's informatics curriculum framework 2000 for higher education

Article *in* ACM SIGCSE Bulletin · December 2001

DOI: 10.1145/572139.572177 · Source: DBLP

2 authors, including:

Fred Mulder
Open Universiteit Nederland
47 PUBLICATIONS **1,233** CITATIONS

SEE PROFILE

Informatics curriculum framework 2000 for higher education

Fred Mulder[1] & Tom van Weert[2]
[1]TSM Business School
PO Box 217, 7500 AE Enschede, The Netherlands
Fax: +31 53 4894848
E-mail: F.Mulder@tsm.utwente.nl
[2]Expert Center for Educational Technology Cetis
PO Box 85029, 3508 AA Utrecht, The Netherlands
Fax: +31 30 2586292
E-mail: T.vWeert@cetis.hvu.nl

Abstract
Informatics is a relatively new discipline, but is nowadays of key importance in all economic processes. Many professionals need development of different informatics backgrounds. The Informatics Curriculum Framework 2000 (ICF-2000) [3] has been designed to cope with a large diversity of demand for informatics education in a controlled way. It offers 8 different curriculum specifications that fit 8 professional role categories. It supports systematic and controlled educational policies in which educational informatics programmes can be developed in a cost-effective way, if need be, from scratch. Learning materials can be developed in the local cultural tradition.

Keywords
computing science, curriculum, informatics

Introduction

In 1998 the International Federation for Information Processing (IFIP) was requested by UNESCO to carry out a project under the title ‘Modular training programme in informatics’. IFIP’s Technical Committee 3 (on Education) adopted the project. It is co-ordinated by the Chair of TC3 and has been executed by members of Working Group 3.2 (on Higher Education), complemented with input from other IFIP Technical Committees.

Rationale behind ICF-2000

IFIP/UNESCO ICF-2000 [3] specifies a state-of-the-art informatics curriculum framework. This offers to institutions and countries where informatics education is still developing, the foundations from which to leapfrog to the fore-front of developments, thus allowing institutions and countries to close the gap. ICF-2000 [3] offers an informatics curriculum framework, from which various curriculum implementation can be constructed in a straightforward way. Implementation depends on cultural, societal and institutional factors. Implementation can also be easily extended without consequence for the curriculum already in use: the ICF-2000 graduate profiles build upon each other.

ICF-2000 allows higher education publishers to produce learning materials in the cultural traditions of their country. Alternatively, popular high quality learning materials from developed countries may be used. This two-fold approach is supported by the many so-called source links in ICF-2000 to other prominent and current informatics curricula from leading professional informatics societies.

The term ‘curriculum’ will be used in this document to mean ‘course of study’. The term ‘curriculum framework’ refers to a set of entities from which government authorities, industry, business and educational institutions may extract their own curriculum, built from knowledge and skills units, in order to achieve a best-fit implementation in their specific cultural, developmental and economical setting.

ICF-2000 is designed in such a way that it can be easily kept up to date. Whenever professional informatics bodies publish an updated curriculum these updates can be easily included in ICF-2000, which thus provides durable access to the state of the art in informatics education.

Terminology

In this paper the term informatics is nothing more than an ‘umbrella’ label. Hence, ‘informatics’ or ‘I’ refers to a diverse, yet related family of domains, including ‘computing’, ‘computer science’, ‘computer engineering’, ‘information systems’, ‘management information systems’, ‘computer information systems’, ‘software engineering’,

'artificial intelligence' or 'AI', 'information technology' or 'IT', 'information and communication technology' or 'ICT', and so on.

Context and relevant trends

Paradox

In the last decade the field of informatics has been subject to ongoing development, extension and linkage with other knowledge domains. In parallel we have witnessed a dramatic increase in demand for informatics and informatics-related university education from a broad and diverse population. Not only is the number of relatively distinct informatics educational programmes growing, but there is also an increasing variety of educational programmes in other disciplines that include informatics components in their core.

Thus, a paradox is arising. At the very same time that informatics education is emerging as an increasingly important part of core education for more and more students, we find a trend towards fragmentation within the informatics field itself. This creates a need for a common vision of the core concepts in informatics education.

Common vision

In August 1997 an international Working Conference was organised by Working Group 3.2 of IFIP on higher informatics education, including university education and higher professional education. Its editorial paper advocates a more integral, generic and coherent approach, and it presents preliminary notions in a search for a shared identity for the informatics field [1].

In a recent issue of Computerworld [2] the necessity to have a common view of the field is underlined. The article discusses the so-called 'discipline problem' in relation to the exploding enrolment of students in computer science studies in the USA.

> *Academia also appears to have a problem sorting out one discipline from the next. "One of the big issues is that the disciplinary boundaries are so fuzzy," says Barbara Simons, president of the Association of Computing Machinery in New York. Academia tends to break computer-related concerns into finer and finer particles, but students may have trouble understanding which major is which. At Berkeley, for example, computer-related studies encompass computer engineering, computer science, electrical engineering, applied math and basic sciences. Some of those areas are put under the umbrella of a College of Engineering, while areas such as IT management are often put under the rubric of Letters and Science.*
> *But while colleges and universities struggle with defining what a computer science major is and isn't, industry must deal with an incoming workforce of graduates that it perceives to be inadequately prepared to face its fast-changing needs.*

These notions and trends are very important for any new informatics curriculum effort. They may even be essential for countries and educational institutions that are in a situation of change and development. In such situations financial constraints are often severe, while the economic need for practical professionals with a general understanding of informatics is very great. Only a state-of-the-art approach will allow leapfrogging to better positions.

Benefits from recent curriculum efforts

There are several precedents of co-operative activities by multiple constituencies to formulate shared curricular goals for (parts of) the informatics field. Among the more prominent of these are:

- *Computing Curricula'91* (to be reviewed and revised in 2001) was produced as a joint effort by the Association for Computing Machinery (ACM) and the Computer Society of the Institute of Electrical and Electronics Engineers (IEEE-CS).
- *Curriculum IS'97* was a joint effort by ACM, the Association of Information Technology Professionals (AITP) and the Association for Information Systems (AIS). This 'information systems' curriculum refers to a detailed IS body of knowledge, includes specific depth of knowledge metrics, and models courses in terms of small learning units.
- *Curriculum ISCC'99* was developed by a task force from industry and academia with support from NSF. It provides an information systems-centric curriculum (ISCC) that is enterprise-oriented, based on a 'profile of the graduate' specified by industry, and that emphasises professional skills.
- An education task force of the IEEE-CS/ACM Steering Committee is currently developing

curriculum recommendations for 'software engineering' to establish Software Engineering as a profession.
- *Curricula for Human-Computer Interaction* was a 1992 report by SIGCHI, ACM's special interest group on computer-human interaction.
- *'A Modular Curriculum in Computer Science'* was produced by IFIP for UNESCO in a revised edition in 1994. It offers a curriculum framework for 'computer science' specifically meant to be applied in developing countries.

ICF-2000 attempts to link to these sources, thus allowing institutions in development to benefit from the many efforts of informatics professionals in the world to produce state-of-the-art curricula.

How to use ICF-2000

The following steps lead to the construction of a state of the art higher education informatics curriculum with ICF-2000:

Step 1 Selection of curriculum specifications fitting the target category of professionals;

Step 2 Selection of graduate profiles from ICF-2000 fitting the educational environment; Balancing the results of Step 1 with the results of Step 2;

Step 3 Producing unit descriptions using world-wide accepted informatics curricula that fit selected curriculum specifications; realisation of extracted curriculum units using widely available learning materials.

In the first step the educational need is identified on the basis of the need for informatics educated professionals in the local economy. These professionals fall into different categories and each category is linked to a specific ICF-2000 graduate profile. In the next step the educational possibilities are identified within the context of the particular circumstances of country and institution. Then the needs and possibilities are brought into balance. In the third extraction step curriculum unit descriptions are produced using the resources of worldwide-accepted informatics curricula. These descriptions may be produced in the local language and in such a way that these fit the local cultural and educational setting. And finally the curriculum is realised using widely available learning materials linked with these worldwide-accepted curricula.

Extraction step 1

Selection of curriculum specifications fitting the target category of professionals

Higher education aims to educate the professionals of tomorrow. Their future professional role decides which informatics knowledge is needed. ICF-2000 distinguishes between three main categories of professionals, acting or interacting with informatics in a broad sense:

A *I-user*
Non-I-professionals using ready made I-technology or I-applications in their work, for example non-informatics professionals using I-applications like text processors or I-technology like digital communication systems (many of the professionals in highly developed economies are I-users today);

B *I-appliers*
Non-I-professionals applying I-knowledge and I-skills in areas different from informatics, for example non-informatics professionals in the economic field who use I-applications to model economic situations;

C *I-workers*
I-professionals working in the field of informatics, for example the system engineer who, as an informatics professional, develops I-applications or I-technology (note that the field of informatics is broad with diffuse boundaries with other disciplines).

I-appliers and I-workers generally will also be I-users, while I-workers may or may not be I-appliers too.

Curriculum specifications adapted to specific professional categories

Depending on their specific future professional role students have different educational needs. ICF-2000 meets these needs through 4 different graduate profiles:

- BIP, Basic Instrumental I-Profile;
- BCP, Basic Conceptual I-Profile;
- MIP, MInor I-Profile;
- MAP, MAjor I-Profile.

ICF-2000 recognises eight subcategories within the three main categories of professionals and not more than four different graduate profiles to efficiently satisfy the educational needs of these professional (sub)-categories.

A I-users

Category of professionals
A1 **INSTRUMENTAL I-USERS**

Graduate profile
BIP Basic Instrumental I-Profile

Size of educational program
20 credit points (total)
16 credit points (generic)
4 credit points (specific)

Prerequisites none

B I-appliers

Category of professionals
B1 **CONCEPTUAL I-APPLIERS**

Graduate profile
BCP Basic Conceptual I-Profile

Size of educational program
40 credit points (total)
32 credit points (generic)
8 credit points (specific)

Prerequisites BIP

B I-appliers (continued)

Categories of professionals
B2 **INTERFACING I-APPLIERS**
B3 **RESEARCHING I-APPLIERS**
B4 **DIRECTING I-APPLIERS**

Graduate profile
MIP MInor I-Profile

Size of educational program
80 credit points (total)
64 credit points (generic)
16 credit points (specific)

Prerequisites BIP, BCP

C I-workers

Categories of professionals
C1 **OPERATIONAL I-WORKERS**
C2 **ENGINEERING I-WORKERS**
C3 **RESEARCHING I-WORKERS**

Graduate profile
MAP MAjor I-Profile

Size of educational program
160 credit points (total)
128 credit points (generic)
32 credit points (specific)

Prerequisites BIP, BCP, MIP

ICF-2000 recognises eight sub-categories within the three main categories of professionals and not more than four different graduate profiles to efficiently satisfy the educational needs of these professional (sub)-categories.

The size of the graduate profiles is 'measured' in terms of credit points: 1 credit point equals one working day (= about 8 hours of study).

Category A actually has no subcategories, but its professionals will be referred to by the code A1, in order to have a uniform referencing system. Categories B and C are divided over respectively four and three subcategories.

Because the graduate profiles build one upon the other, an efficient curriculum structure results. However, professional categories B2, B3 and B4 have characteristics leading to differences within the identified graduate profile MIP. And professional categories C1, C2 and C3 have characteristics leading to differences within MAP. These differences concern:

- The coverage of a set of informatics themes;
- The orientation in terms of goals and competencies to be reached.

Core curriculum themes

ICF-2000 'fingerprints' a graduate profile for a specific professional category with respect to a set of twelve core curriculum themes taken from [1]:

1. Representation of information;
2. Formalism in information processing;
3. Information modelling;
4. Algorithmics;

5. System design;
6. Software development;
7. Potentials and limitations of computing and related technologies;
8. Computer systems and architectures;
9. Computer-based communication;
10. Social and ethical implications;
11. Personal and interpersonal skills;
12. Broader perspectives and context (including links with other disciplines).

Professional orientations

ICF-2000 ‘fingerprints' a graduate profile for a specific professional category with respect to a set of four major possible orientations:

AWAWareness (know or use)
Aiming at developing basic knowledge as well as skills that allow students to act basically in literate ways with respect to informatics in general and to perform standard operations using computer technology or software packages;

AP APplication
Aiming at developing a basic conceptual understanding of informatics and of some more advanced informatics skills which allow students to apply basic informatics to other disciplines or areas;

DMDesign and Modelling
Aiming at developing a general understanding and broad overview of informatics, especially with respect to the modelling and the design of informatics applications;

CA Conceptualisation and Abstraction
Aiming at developing a thorough understanding of and well-developed skills in informatics as a broad discipline, the essence being to further develop the capability of students to abstract and to conceptualise.

An example of a curriculum specification is given in Table 1.

Graduate I-profile	**BIP**	**BASIC INSTRUMENTAL I-PROFILE**															
Categories of professionals	A1	Instrumental I-users															
		credit points (total)		credit points (generic)				credit points (discipline specific)									
Size of educational program	***BIP***	***20***		***16***				***4***									
Prerequisites	none																
Constituting units			*size*	*orien-*	*themes*												
code	*title*		*[cp]*	*tation*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	
[--- generic ---]																	
BIP-01	Context for informatics applications [1]		3-5	AW	x		x		x		x	x	x	x		x	
BIP-02	Hands-on with software packages [1]		3-5	AW	x		x	x			x	x			x		
BIP-03	Hands-on with software packages [2]		3-5	AW	x		x	x			x	x			x		
BIP-04	Hands-on with networking [1]		3-5	AW	x						x		x		x		
[--- discipline(X) specific --- X may be I ---]																	
BIP/X-01	Operating software in area X [1]		4	AW								x				x	x
	Total size & theme ‘fingerprint’		**20**	**AW**	**4**		**3**	**2**	**1**		**5**	**3**	**2**	**1**	**4**	**2**	

1 credit point (cp) = 1 day of study

Table 1: Curriculum specification of BIP

Extraction step 2

Selection of graduate profiles fitting the educational environment

ICF-2000 offers a considerable degree of freedom in the implementation of an actual curriculum in specific cultural and societal settings that are influenced by numerous implementation factors. The context is that of higher education institutions where major and minor degrees in disciplines other than informatics are awarded.

Each of the four graduate profiles mentioned before demands specific resources from the educational institution. Using a table that shows the relationship between institutional characteristics and preferred options profiles are identified which fit the local circumstances. From this starting point educational institutions may develop informatics curricula in a gradual and efficient way, both in terms of resources and personnel. This is facilitated by the fact that ICF-2000 graduate profiles build upon each other.

Balancing results of step 1 with the results of step 2

Professionals are needed in the society in which educational institutions operate; the future professional role of students decides which informatics knowledge is needed. This educational need is identified by Extraction Step 1.

On the other hand important resource factors in the situation of an educational institution (or a country) will decide which graduate profiles may be delivered within the local boundary conditions. This is the result of Extraction Step 2.

There may be a mismatch between what is needed (considering the needs of the local economy, Step 1) and what is possible (considering the situation of the educational institution, Step 2). One way or another such a mismatch must be resolved. Either new resources have to be allocated to the educational institution to meet the requirements of the graduate profiles to be offered or particular categories of professionals have to be educated elsewhere or brought in from elsewhere.

In a case where the resources of an institution are not sufficient to offer a particular profile, another – less demanding profile – may be offered. Once the situation has changed, the educational offer can be easily extended to the more demanding profile. This can be done without consequences for the initial profile that is being offered already, as ICF-2000 graduate profiles build one upon the other.

Extraction step 3

Producing unit descriptions using world-wide accepted informatics curricula

Each graduate profile is further described in terms of curriculum units (such as in Table 1). Appropriate units can be selected. Each curriculum unit in turn is specified by referring to a number of important and current informatics curriculum sources, whereas the contents are classified through reference to:

CCS: ACM Computing Classification System;

UCSI: Unified Classification Scheme for Informatics (UCSI) (see the paper by Mulder and Hacquebard in [1]).

An example of a unit description is given in Table 2.

BIP-01	**CONTET FOR INFORMATICS APPLIATIONS [1]**	**3-5 CP**
*Targeted **competencies***	- the capability to basically recognise the context (business-wise, societal, individual, technical, managerial and historical) in which informatics applications are introduced and used - the attitude of being critically aware of the potentials of informatics applications	
Learning approaches	th ex	
Curriculum references		
CC91	Knowledge units AL AR DB HU PL SP1-3	
IS97	Courses 1 3 4	
ISCC99	Courses 11/1.0 21 22 41 42 43	
HCI92	Courses CS1 CS2	
>>> ***ECDL***	**Module 1**	
Classification		
CCS	B.0 C.0 D.0 E.0 H.0 I.0 J.0 K.1-2,3.0-7.0	
UCSI	1 2 3 4.1-4	

Learning approaches

th *Theoretical:*
The approach is to transfer information and to interact on it.

ex *Exercising:*
The approach is to transfer information by letting students solve problems of various kinds (both abstract and concrete), generally with pencil and paper.

Main source reference: >>> ECDL Module 1

Table 2: Example of a ICF-2000 unit description

Making a concrete unit description

A concrete unit description is made from the ICF-2000 unit description using the references given. In the example in Table 2 the main reference is to the European Computer Driving Licence, Module 1. The actual units can be described in the local language and within the local cultural and educational tradition. However, when composing the concrete unit description, the specific coverage of themes, the specific orientation and the specific learning approach have to be taken into account. Once the curriculum has been described according to local culture and educational setting, it can be realised in practice. Learning materials are essential for this. The current informatics curriculum sources referred to by ICF-2000 have drawn on existing, widely available learning materials and resources, but also have led to the production of new learning materials and resources. For example, for the unit in Table 2, with the main reference to ECDL, many learning materials in various European languages have been developed and are widely available.

The internet and the World Wide Web have much to offer in terms of freeware and shareware resources. Other possibilities could originate from collaboration with business and industry, or from international co-operation with sister institutions. Also governmental or non-governmental agencies for the support of developing countries may be able to help.

Keeping ICF-2000 up to date

Developments in the field of informatics are very fast. This means that curricula and study materials have to be updated all the time. ICF-2000 is a framework that refers to major widely accepted and widely implemented informatics curricula and associated resources. Much effort is put into keeping these curricula up to date. For example, the ACM/IEEE-CS Computing Curriculum '91 is currently under revision. The revised curriculum is expected in 2001. To keep ICF-2000 up to date with this development the appendix in the full report on ICF-2000 describing ACM Curriculum '91 has to be updated to describe ACM/IEEE-CS Curriculum 2001. In ICF-2000 itself only the references to this appendix have to be updated. In this way ICF-2000 can be kept up to date with relatively little effort. An updating mechanism is proposed in ICF-2000 to assure this process.

References

1. Mulder, F. & van Weert, T.J. (eds.) (1998) *Informatics in higher education: Views on informatics and noninformatics curricula*. Proceedings of the IFIP/WG3.2 Working Conference on ‘Informatics (computer science) as a discipline and in other disciplines: what is in common?’. London: Chapman & Hall.
2. Fryer, B. (1998) ‘The student population boom’. *Computerworld*, October 19, 1998; http://www.computerworld.com/home/print.nsf/idgnet.
3. Curriculum Framework ICF-2000. http://Poe.netlab.csc.villanova.edu/ifip32/

Biography

Since December 1998 Fred Mulder has worked at TSM Business School, the management institute of the three Dutch universities of Twente, Groningen and Eindhoven. He is still associated (honorary) as a professor of informatics education with the Dutch Open University, where he worked from the opening of the institute in 1983 and held the chair on informatics education since 1991. He is member of IFIP Working Group 3.2 on Informatics and ICT in higher education.

Since September 1998 Tom J. van Weert has been the managing director of the Expert Centre for Innovation and Educational Technology of the Hogeschool van Utrecht, University of Professional Education and Applied Science, The Netherlands. Previously he was director of the school of informatics (computer science) of the faculty of mathematics and informatics of the University of Nijmegen, The Netherlands. He is a member, and currently chairperson, of IFIP Working Group 3.2 on Informatics and ICT in higher education.