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Profiles of informatics graduates as demanded by the market

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Abstract

The professional field puts demands on the qualifications of informatics graduates. These demands have important consequences for the informatics curriculum in higher education. This should provide a good fit between the qualifications of graduates and the demands of the professional practice. A project group recently has described four profiles for informatics graduates based on both these demands and a view on developments in informatics. These profiles are linked to the domains of business administration, technical work, systems exploitation and management, and software engineering. For each of the profiles the qualifications have been characterized by a level in a (simplified) taxonomy of Bloom.

Keywords

Informatics, economics and business administration, higher vocational education, curriculum (general), levels of competence, business and industry requirements, educational profiles, professional profiles

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1 INTRODUCTION

The Dutch informatics schools in professional higher education (HBO) cooperate in the so-called 'HBO-I platform'. This platform aims to develop a clear description of content and position of the informatics education in these informatics schools. Already in 1992 the demand of industry and other business areas for informatics graduates was investigated as part of a project for quality improvement of informatics education (KIO, 1993b). A subsequent project investigated the profiles of the informatics profession (HBO-I, 1994). And a third project had four goals, namely to:

- design profiles for informatics education following recommendations of the 1994 visitation committee which inspected the quality of professional higher informatics education in all HBO-I schools;
- provide a clear description of education at the HBO-I schools;
- offer a frame of reference for HBO-I schools;
- present a method for implementation and maintenance of the informatics curriculum.

An eventual aim was to:

- realize a general and broad informatics education focused on general (business) information systems, on automation of production and on software as a product or in products;
- realize a business study programme with informatics as a substream (25% of the curriculum).

The project team started in September 1995 and reported (Van Leeuwen *et al.*, 1997) in 1997. This paper describes the project and its consequences.

2 PROFESSIONAL HIGHER EDUCATION IN THE NETHERLANDS

For a better understanding we sketch the situation of the Dutch informatics schools in professional higher education and some developments relevant to the project discussed.

Higher education in The Netherlands consist of two types: HBO (professional higher education) and WO (academic higher education). HBO graduates earn a Bachelor's degree. WO graduates earn a Master's degree. This paper deals with informatics schools at universities for professional education (HBO).

In 1971 the first two informatics schools started in HBO and now there are about 30. Two types have emerged:

- Schools for Higher Informatics (HIO), generally concentrating on software engineering and technical contexts;
- Schools for Business Informatics (BI) aimed at application of informatics in business and economical context.

In 1987 a new type of school emerged, combining HIO and BI in one school for Informatics and Information and integrating education for both types of graduates (HIO and BI).

In the eighties the profession was undergoing profound transformations. Individual schools had to cope with these changes and make their own curriculum choices in which they had much freedom. Cooperation between HIO-schools was weak; BI-schools worked more closely together. A large diversity of curricula resulted. In the nineties it became clear that this lack of cooperation hindered improvement of informatics education. A project, called KIO (KIO, 1993), was started in which all 30 schools (HIO and BI) cooperated and which resulted in the HBO-I platform.

An external stimulus for cooperation followed from the external quality audit of the HBO. All schools of informatics in the HBO were inspected by a so-called visitation committee consisting of experts in the field of informatics, industry and education. Their report 'From isolation to integration' (HBO-Raad, 1994) contained important views, conclusions and recommendations.

3 PROBLEM DESCRIPTION

The problem has been described in the introduction. And from that description the question arise: How can we identify educational profiles? An understanding of the demands of the professional field in the coming years is required. And experiences from earlier projects show that the labour market does not speak with one tongue about these demands. Another question is: What are the tasks our graduates have to perform in the first years after graduation? Important sources for the answer to this question are found in task descriptions published by informatics societies. These may be updated by more recent articles and interviews. And then there is the question of how to select particular task descriptions which can be transformed into qualifications which students have at graduation? How to formulate exit qualifications and how to express the level of expertise? And the last, but by no means the easiest question: How to derive educational profiles from exit qualifications?

4 SOME CLARIFICATION ON TERMS USED IN THIS PAPER

What is meant by the term 'professional profile'?. It is the description of a coherent set of tasks of a HBO-I graduate professional performed a few years after graduation. This profile is not linked to functions, but to tasks. Starting from this set of tasks we can derive qualifications which graduates should have on graduation, as beginning professional. These qualifications are called 'exit qualifications' of a study programme. 'Learning objectives' are intermediate objectives in an educational program leading to the exit qualifications. These are, however, not discussed in this paper.

5 THE RESEARCH

Our first task was to investigate the literature for task descriptions in the informatics. The most complete description was found in the report 'European Informatics Skill Structure' (EISS, 1992) of the Council of European Professional Informatics Societies, CEPIS. This report proved to be of large value because it provides an in-depth and detailed view of knowledge and skills of informatics professionals. Also the Dutch Informatics Society reports in 1989 and 1993 (NGI, 1989; NGI, 1993) were studied. The findings were published in a report (KIO, 1993).

When selecting tasks for identifying exit qualifications we made some restriction and confined ourselves to informatics education. The problem to decide what informatics is was solved by choosing the Unified Classification Scheme of Informatics, UCSI (Mulder, 1992) as a framework. We also excluded tasks as described in EISS in training, hardware engineering, research, boundary spanning management, procurement and contracting, sales and marketing and technical authorship. Some of these subfields were not open for our graduates in the first years of their career, others were not at the right level of professional education or too specific. A second selection concerned task levels. The HBO-I graduates are at the EISS level of trained practitioner (level 3), fully skilled practitioner (level 4) and in some aspects even at a higher level. A last criterion in selecting exit qualifications was time independence: We excluded those qualifications which strongly depend on hypes and questionable 'trends'.

To reformulate task qualifications into exit qualifications requires some guidelines. Every exit qualification has two parts (an operational sentence and a sentence which specifies the object of the operation) and has a skill level in the taxonomy of Bloom (Bloom, 1956). The skill level can be implicitly derived or explicitly mentioned. The operational part of an exit qualification can be

formulated as: 'the student knows ...' (k), 'the student can describe ...' (k), 'the student can explain why ...' (u), 'the student can perform ....' (a), 'the student has the skill to ...' (a), 'the student can evaluate ...' (m), 'the student can create new ways for doing ...' (m). The skill level is indicated in parentheses: 'k' stands for knowledge, 'u' for understanding, 'a' for application skill and 'm' stands for 'more': evaluation, analysis and synthesis. For pragmatic reasons we have put the last three levels into one.

To supplement the set of qualifications derived from EISS, other sources were studied resulting in some new exit qualifications reflecting more recent or special topics. Some activity models were helpful: the information systems bi-cycle, the reference model of the Open University course Methodology of information system development (Lemmen, 1993), the I-matrix of an earlier project Profiles for the informatics profession (HBO-I, 1994) and the system management model of Looijen (Looijen, 1995). There are, of course, also exit qualifications which hold for HBO-graduates in general. We have put these in a special category: HBO General.

In the end we got a rather complete set of exit qualifications covering more than can be done in a four year programme. So a choice has to be made. A special property of the set is that not all qualifications cover the same scope: some deal with aspects that are to be learned in short time, others require a long period time. An experiment to formulate qualifications with the same scope failed.

6 EDUCATIONAL PROFILES

6.1 Description of a profile

A profile of a study programme has as characteristics:

- a set of exit qualifications;
- division of the study load over a number of components;
- an overall view.

Exit qualifications are selected on the basis of the study load and the view. In our case the study load of informatics was 50% of the total curriculum, of which 37.5% is common to all profiles and 12.5% can be different. Each profile is further linked to a characteristic domain. The resulting model is shown in Figure 1.

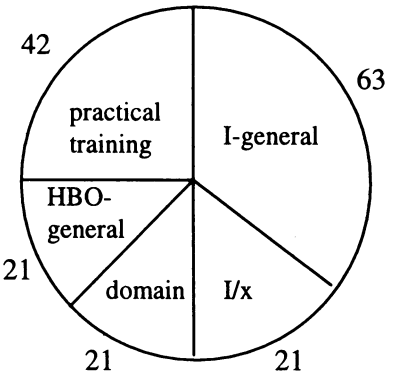

Figure 1 Components of a broad informatics study programme.

The right half of the circle is the informatics part. The half of the circle to the left hand side consists of the practical training, HBO general and the domain. The numbers indicate the number of allocated study points (one study point is 40 hours of study). Each study year consists of 42 study points. Each profile is different in the parts domain and informatics implied by the domain (I/x). In a study programme the notation of the principal field of study is a capital (I for informatics, BA for business administration and X for any other domain). A secondary field in the programme is indicated in lower case, separated from the principal field by a slash. So I/ba is the profile of the informatics study programme which has as its secondary field business administration. I/i is the profile of informatics education specializing in a typical subtopic of informatics.

6.2 Informatics and business administration

All profiles I/x are part of informatics education and all have the characteristic that they are innovative with respect to computer systems, software systems and information systems and their development. The common part of informatics education offers general knowledge of informatics, skills in specification and development of software and information systems, and knowledge of system management. All informatics graduates therefore can fully participate in the development process which is a market demand.

In parallel another task group has developed a profile for the BA/i business administration study programme (BA/i, 1996a and 1996b). The general objective of this programme is to educate experts who can improve business processes applying information and communication technology to that end. The model is shown in Figure 2.

6.3 Identification of profiles

The investigation of exit qualifications had made clear that a big number of applications of informatics is in the business domain. So one of the I-profiles will be in this domain: the I/ba profile. A second important domain is the technical field. This differs substantially from the business administration domain because of the close interaction with technical artefacts and processes. This results in the I/t profile. Information services is a domain strongly emerging. The ever changing, enormous diversity in computer systems, software systems and information systems requires systematic management based on powerful concepts. This is not a skill for scientific profiles, but relevant for HBO-I. The third profile is therefore exploitation and management, I/e&m. Last but not least the problem of designing and realising complex systems for any environment asks for skills in software engineering which surpass the level of the I-general component of the curriculum. This profile is I/i.

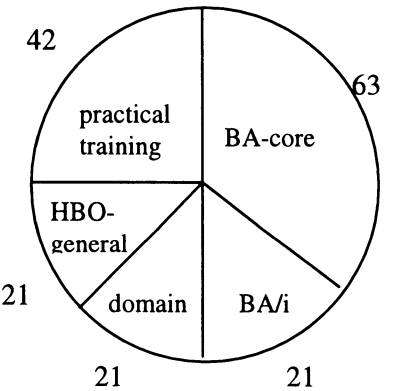

Figure 2 Components of a business administration with informatics study programme.

6.4 Summary of informatics profiles

We distinguish the following informatics profiles (I/x).

I/ba: informatics in the business domain
Graduates of I/ba are able to apply information and communication technology to support business operations and the (re)design of business processes. They are able to play a role in the development of business systems. The analysis of processes and of information is more developed than in the I-general part of the curriculum.

Information policy, change management, quality management and project management are exit qualifications and expand the general I-skills. From business administration topics as business organizations and processes, business economics, information facilities are chosen.

I/t: informatics in technical domains

Information and communication technology is incorporated in technical products and plays an increasing role in production processes. Embedded software is strongly interacting with other parts of the products. There are special requirements for correctness, robustness and ease of use. In most cases special demands are posed upon the use of resources such as memory. In the development of these products the design of hardware and software is concurrent. Another aspect in I/t is the application of informatics in production and process control. Topics of informatics specially related to this profile are process control, real time systems, fault tolerance, robotics, digital signal processing, CAD/CAM and simulations software. And from technical perspective measuring methods, interfacing between technical and computer systems, support of logistics and image processing.

I/e&m: exploitation and management

The installed base of computer systems, software systems and information systems needs application management. From a business point of view this concerns the question of how installed systems function so that they optimally support business processes, operations and organizations. To the I-general part of the curriculum data management, application management, system software, client/server, network management and management of development environments are important in I/e&m. This profile has components of operational management, user service delivery, help desk, system administration. These are in fact special topics of business administration.

I/i: software engineering

The study of problems in designing and implementing large and complex software systems is software engineering. Application of scientific knowledge and methods is supplemented with personal skills. The complexity in software engineering is not the context of the business, but the context of the software and computer systems in which the new software should function. The I-general part of the curriculum is extended with data structures (objects) and algorithms, compiler design, database management systems, artificial intelligence, computer architecture, networks and operating systems. For the software process software quality management is a topic with an increasing attention in the field.

The profiles in tables

The profiles may be described in tables with the following structure (see Figure 3). In the last five columns a letter denotes the skill level of Bloom. No letter means: not required in this part of the curriculum or for this profile.

Code	*Exit qualification*	*I-general*	*I/ba*	*I/i*	*I/t*	*I/e&m*
	knows about ...	k	k	u	u	a
	can apply	a	a	a	m	a
	can explain why ...		u	u		a
	can evaluate and create					

Figure 3 Example of a table describing the profiles
(k = knowledge level; u = understanding level; a = application level; m = more, i.e. a level above application (analysis, synthesis, evaluation)).

7 CONCLUSION

The profiles and exit qualifications described in this paper turn out to be of practical use for informatics education and for the informatics profession. For informatics education they offer a frame of reference and a starting point for further development of curricula. By evaluating the topics in the study programmes with respect to this set of qualifications schools can determine which profiles they want to offer. The total set of qualifications supports schools in selecting their own exit qualifications and intermediate objectives.

It is obvious that the work reported in this paper is not the final solution in curriculum development, but still it offers a good starting point for future work. Also some questions are still open. For instance the question of how to project (subsets of) exit qualifications onto study points. The work reported here is highly time independent, but not totally. So regular updates, at least every three years, are advised.

8 ACKNOWLEDGEMENTS

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9 REFERENCES

Bloom, B.S. [ed.] (1956) *Taxonomy of educational objectives: Cognitive domain.* David McKay, New York.

BK/i (1996a) *Over BK/i: een nieuwe opleiding.* Werkgroep BK/i [in Dutch].

BK/i (1996b). *Eindtermen BK/i.* Werkgroep BK/i [in Dutch].

DOZ (1989) *Doelen formuleren in het onderwijs.* DOZ boek 1, Werkgroep Docenten Onderwijszaken [in Dutch].

EISS (1992) *European Informatics Skills Structure, a set of performance standards covering all functional areas of work carried out by professionals in informatics* Council of European professional Informatics Societies (CEPIS.

HBO-I (1994) *HBO-I op weg naar beroepsprofielen.* Rapportage HBO-I platform 1993 -1994, Deel III, HBO-I-platform [in Dutch].

HBO-Raad (1994) *Van isolement naar integratie.* Eindrapport van de visitatiecommissie informatica-opleidingen, HBO-Raad, Den Haag [in Dutch].

KIO (1993) *HBO-I Informatica.* KIO-rapportage, overzicht, KIO [in Dutch].

KIO (1993b) *KIO, Rapport project Uitstroom.* Onderdeel van de rapportage Kwaliteitsverbetering Informatica Onderwijs [in Dutch].

Lemmen, K.A.M., *et al.* (1993) *Methodologie van informatiesysteemontwikkeling.* Open universiteit, Heerlen [in Dutch].

Looijen, M. (1995) *Beheer van informatiesystemen.* Kluwer Bedrijfswetenschappen, Deventer [in Dutch].

Mulder, F. (1992) *Identiteit van informatica-onderwijs.* Inaugurale rede Open universiteit, Heerlen [in Dutch].

NGI (1989) *Functies in de technische informatica; een voorstel tot ordening van taken en functies op het gebied van de technische informatica.* NGI-commissie beroepsontwikkeling, Kluwer Bedrijfswetenschappen, Deventer [in Dutch].

NGI (1990) *Het organiseren en controleren van het systeembeheer.* Rapport van de werkgroep systeembeheer binnen de sectie EDP-Auditing, NGI, Amsterdam [in Dutch].

NGI (1993) *Taken en functies in de bestuurlijke informatica; een voorstel tot ordening.* NGI-commissie beroepsontwikkeling, Kluwer Bedrijfswetenschappen, Devehter [in Dutch].

Van Leeuwen, H., Berends, T.M., Dicker, L.M.M., Huffels, N., Woolderink, A.J. (1997) *Opleidingsprofielen HBO-I.* HBO-I Platform [in Dutch].

10 BIOGRAPHY

After teaching eleven years at primary and secondary schools, Henk van Leeuwen became a lecturer at the school for Hogere Informatica at Enschede in 1984. He received his Master's degree in mathematics and informatics from the University of Utrecht in 1985. In 1988 he became head of the informatics department at the Hogeschool Enschede. Now he teaches informatics and is coordinator of the IT-stream in a quality project in the Hogeschool Enschede. In 1992 he was chairing a project investigating the demand of industry and other organizations for informatics graduates. He was chairing the project reported here.

Deny Smeets studied electrical engineering at the University of Twente in Enschede. He worked during 2 years for the International Telecommunication Union in Dacca, Bangladesh. After that he has developed during six years informatics courses for distance learning at Dirksen Opleidingen. Since 1985 he is working as lecturer at the Technical Faculty of the Hogeschool van Arnhem en Nijmegen. He is co-author and editor of the book 'Program development in Pascal' and editor of TINFON, a Dutch journal for informatics education. At the moment he is director of the school for Informatics (HIO) at the Hogeschool van Arnhem en Nijmegen. During 1991-1996 he was chairing the HIO-platform and the HBO-I platform.