The GMDS Competence Catalogue for (Bio-)Medical Informatics and Health Information Management Bachelor Programs

Der GMDS-Kompetenzkatalog für Bachelor-Studiengänge der (Bio-)Medizinischen Informatik und des Medizinischen Informationsmanagements

Abstract

Background: The digitalisation of the healthcare system is closely linked to medical informatics, biomedical informatics and medical information management. These disciplines require optimally trained specialists with specific skills.
Objective: To develop a competency catalogue to support the design of curricula for bachelor programs in medical informatics, health information management, and biomedical informatics.
Methods: A group of experts developed a competency catalogue based on a series of workshops, reviews of current degree programs, and international and national recommendations.
Results: The GMDS Competence Catalogue for (Bio-)Medical Informatics and Health Information Management Bachelor Programs was developed, consisting of 234 competences divided into four chapters and 51 topics.
Conclusions: The catalogue provides a toolbox of potential competences to be taught for developing or describing the profile-specific range of competences of a study program. It can support the development and accreditation of study programs as well as the comparison of study programs.

Keywords: recommendations, curricula, competency catalogue, bachelor programs, medical informatics, biomedical informatics, health information management

Zusammenfassung

Hintergrund: Die Digitalisierung des Gesundheitswesens ist eng mit der Medizinischen Informatik, der Biomedizinischen Informatik und dem Medizinischen Informationsmanagement verknüpft. Diese Disziplinen erfordern optimal ausgebildete Fachkräfte mit spezifischen Kompetenzen.
Zielsetzung: Entwicklung eines Kompetenzkatalogs zur Unterstützung der Gestaltung von Curricula für Bachelor-Studiengänge der Medizinischen Informatik, des Medizinischen Informationsmanagements und der Biomedizinischen Informatik.
Methoden: Eine Expert:innengruppe entwickelte einen Kompetenzkatalog auf der Grundlage einer Reihe von Workshops, der Überprüfung aktueller Studiengänge sowie internationaler und nationaler Empfehlungen.
Ergebnisse: Der GMDS-Kompetenzkatalog für Bachelor-Studiengänge der (Bio-)Medizinischen Informatik und des Gesundheitsinformationsmanagements bestehend aus 234 Kompetenzen, die in vier Kapitel und 51 Themen unterteilt sind.

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Schlussfolgerungen: Der Katalog bietet einen Werkzeugkasten potenziell zu vermittelnder Kompetenzen für die Entwicklung oder Beschreibung des profilspezifischen Kompetenzspektrums einschlägiger Studiengänge. Er kann die Entwicklung und Akkreditierung von Studiengängen sowie den Vergleich von Studienangeboten unterstützen.

Schlüsselwörter: Empfehlungen, Curricula, Kompetenzkatalog, Bachelor-Studiengänge, Medizininformatik, biomedizinische Informatik, Gesundheitsinformationsmanagement

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Introduction

Digitalization of the healthcare system has become a key and growing success factor for healthcare and medical research [1]. Closely linked to this are the scientific fields of medical informatics, biomedical informatics and health information management [2]. These disciplines have been evolving for more than 55 years, most recently particularly in the field of biomedical informatics [3]. Despite different specializations, the common goal of these disciplines is to improve the structures, processes and quality of results in healthcare and medical research using modern information technology methods and tools. To achieve this, optimally trained specialists in these disciplines are needed. On the one hand, digital skills are relevant for healthcare professionals working primarily in healthcare and medical research. The digital skills relevant to this group of professionals focus primarily on the professional use of the multitude of digital tools and methods for this area of application. On the other hand, specific skills are required for specialists in medical or biomedical informatics and health information management who develop these digital tools and manage or evaluate their use in healthcare practice or medical research.

To ensure high-quality training in these fields of work, framework specifications for the design of curricula have generally been published by scientific societies at national or international level. An example on an international level are the Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics published in its second edition in 2023 [2]. The recommendations are broad-based and cover training from biomedical and health informatics (BMHI) professionals to BMHI users, thus covering both target groups mentioned above. The paper also contains a comprehensive compilation of national and international framework recommendations for training in the context of BMHI. An example at national level, which is aimed exclusively at medical professionals, are the national competency-based learning objectives "Medical Informatics" for undergraduate medical education in Germany [4]. The reason for the multiple definition of framework concepts for training in the BMHI context at national and international level lies in the historical development of the disciplines and training programs in the respective countries, which also do not necessarily share the same professional role definitions. In Germany, for example, a large number of study programs have been developed over the past decades in the subject area of BMHI. Examples include degree programs in medical informatics, health informatics, medical-technical informatics, bioinformatics, information management in healthcare or medical information management, to name but a few. All these programs can be assigned to the BMHI environment but can differ greatly from one another in terms of curricular comparison.

Against this background, the Presidium of the German Society for Medical Informatics, Biometry and Epidemiology (GMDS) set up the current working group (WG) "Curricula in Medical Informatics" (CMI) in 2014 with the task of developing recommendations for curricula for university education in medical informatics and related

subjects, taking into account current and future requirements from science and practice. In doing so, requirements for BMHI training from an international perspective or corresponding training recommendations, e.g. from the IMIA, are to be taken into account. In addition, three perspectives should be included and differentiated from one another:

- medical informatics (MI)
- health information management (HIM)
- biomedical informatics (BMI)

In line with this mandate, the CMI WG was initially composed of 13 and currently 14 representatives of university programs from the aforementioned areas as well as from professional practice, namely the KH-IT Bundesverband der Krankenhaus IT-Leiterinnen/Leiter e.V. (engl. Federal Association of Hospital Chief Information Officers) and the Bundesverband Gesundheits-IT (bvitg e. V., engl. German Association of Healthcare IT Vendors).
The CMI WG focused its first activities on the development of a catalogue of competencies for bachelor programs for MI, BMI and HIM. In the following, we use the generic term BMHIM for study programs in these three areas, which includes explicitly HIM in addition of the abbreviation BMHI of the IMIA, which focuses on biomedical and health informatics. The aim was to develop a catalogue of competencies that

1. supports the development of corresponding university curricula and the range of competencies to be taught,
2. enables a competence-based comparison of degree programs, especially for prospective students and employers, and
3. supports the accreditation of relevant degree programs.

In the following, the methodology used to develop this competence catalogue is described, the current version of the competence catalogue is presented, and the results are discussed. The competence catalogue was consented in a multi-stage process involving the members of the CMI working group, the relevant experts involved for collaboration and comment, the GMDS Medical Informatics Division and finally the GMDS Presidium.

Methods

The methodological approach to developing the competence catalogue was based on a series of workshops of the working group as well as working sessions between these workshops and included the following steps starting in December 2015:

1. Review of current BMHIM degree programs in German-speaking countries in order to obtain an overview of the range of degree programs in terms of content and structure.
2. Review of the relevant international and national recommendations, frameworks and guidelines for training in the BMHIM subjects concerning their suitability in terms of content and structure for describing framework recommendations for training in BMHIM in German-speaking countries. The following were considered in detail:
   a. The IMIA Recommendations on education in biomedical and health informatics (first Revision) [5],
   b. the Health Information Technology Competencies (HITCOMP) tool, an interactive instrument to assess global health information technology (HIT) skills – meanwhile offline. It originated from a cooperation of the US Department of Health and Human Services and the European Commission [6],
   c. the Global Academic Curricula Competencies for Health Information Professionals of the American Health Information Management Association (AHIMA) in cooperation with the International Medical Informatics Association (IMIA), the International Federation of Health Information Management Associations (IFHIMA) and the Irish Computer Society (ICS) [7],
   d. the National Competence-Based Catalogue of Learning Objectives in Medicine (dt. Nationaler Kompetenzbasierter Lernzielkatalog Medizin NKLM) for medical degree programs in Germany [8] and
   e. the recommendations for training and study degrees in medical documentation and health information management of the German Professional Association for Documentation and Information Management in Medicine (dt. Fachverband für Dokumentation und Informationsmanagement in der Medizin DVMD).
3. Definition of the structure and scope of the description of the planned curricular recommendations: A competency-based approach was chosen, which divides the potential competencies to be taught into chapters, topics and subtopics of a competence catalogue. For reasons of international comparability, the structure of the competence catalogue was based on the Recommendations of the IMIA on education in biomedical and health informatics from 2010 [5], whose hierarchical structure into topics and sub-topics was the basis for the division of the competence catalogue into chapters, topics and sub-topics. To keep the catalogue manageable, it was agreed that, as a rule, only five central competencies per sub-topic should be described. However, minor deviations from this rule should be possible.
4. Definition and implementation of the process for developing the curricular recommendations, the consensus procedure and the stakeholders to be involved:
   a. Review of the IMIA-based subdivision into chapters, topics and sub-topics for applicability and completeness. In this step, some topics and subtopics were reorganized, supplemented or adapted and finally agreed upon.
   b. For each sub-topic of the competence catalogue, mentors were selected from the CMI WG. These mentors were responsible for describing the competencies relevant to the respective sub-topics, whereby

external experts and, if necessary, other framework recommendations could also be included.
c. Internal review of the developed competencies for completeness and any need for changes with the involvement of selected external experts, in particular from the SMITH – Joint Expertise Center for Teaching (SMITH-JET) working group of the German Medical Informatics Initiative (MI-I) [9], who have developed a catalogue of competencies for the training and further education of digitization experts in the context of the MI-I [10].
d. Submission of the catalogue first to the GMDS Medical Informatics Division and then to the GMDS Presidium with subsequent publication of the catalogue in German in September 2021 on the GMDS website (version 1.1 from December 2024 after editorial revision [11]) and in English in January 2025 (version 1.2 from April 2025 after minor editorial revision [12]) and as supplement to this article (Attachment 1)).
e. Revision and updating of the catalogue every 5 years starting in 2026.

Results

The catalogue of competences for BMHIM Bachelor degree programs was published as the first result of the CMI's work. The catalogue is structured hierarchically and is divided into four **chapters**, the chapters into a total of 13 **topics**, the topics into a total of 51 **sub-topics** and the sub-topics into individual **competences** to be acquired (234 in total). The chapters and topics are as follows:

1. Core competences and core skills in medical informatics, health information management and biomedical informatics
   1.1. Prerequisites and basics
   1.2. Medical documentation and medical data management
   1.3. Information systems in medical care
   1.4. Cross-institutional information systems for medical care (health telematics and consumer health informatics)
   1.5. Medical-technical informatics and bioinformatics
   1.6. Information systems in medical research and teaching
2. Expertise in medicine, health and life sciences, organization of the healthcare system
   2.1. Medicine, health and life sciences
   2.2. Organization of the healthcare system
3. Expertise in computer science, mathematics and biometrics
   3.1. Informatics and computer science
   3.2. Mathematics, biometrics and decision support
4. Personal competences
   4.1. Self-competence
   4.2. Methodological competence
   4.3. Social competence

Figure 1 provides an overview of the subject areas and the number of competences specified in each.

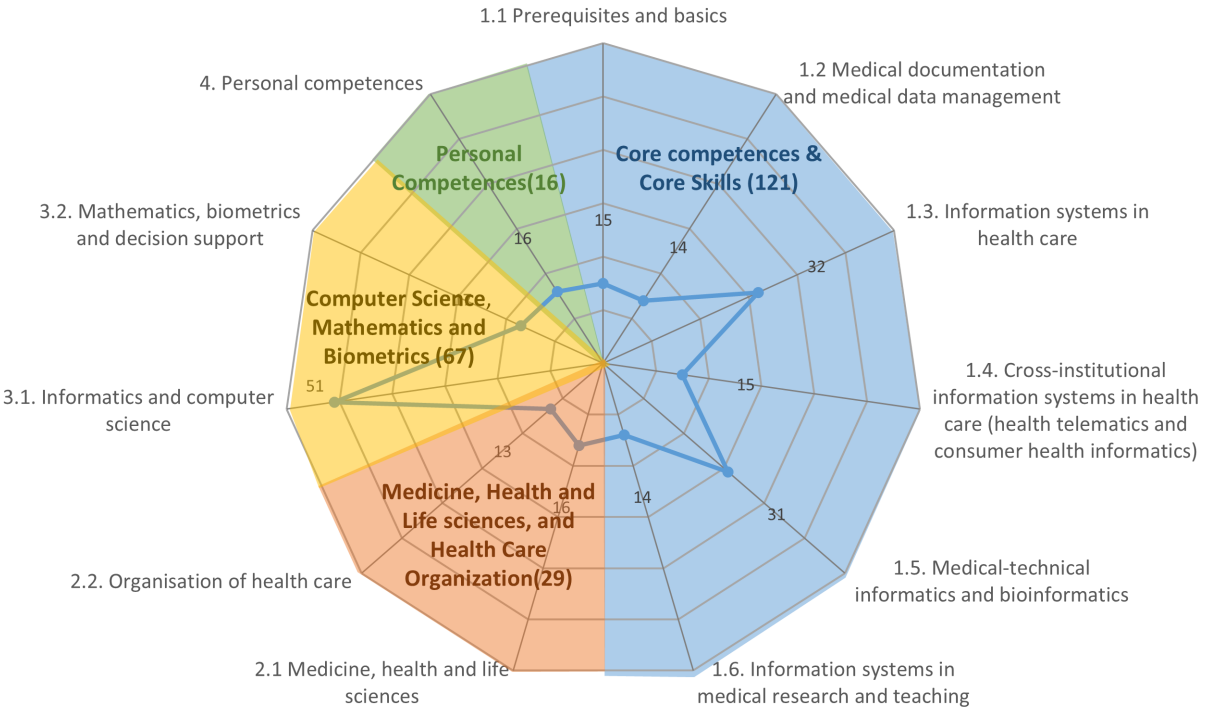

Figure 1: Chapters, topics and number of competences per topic and chapter in the competence catalogue. The blue line shows the distribution of competences across the topics.

Chapter 1 Core competences and core skills in medical informatics, health information management and biomedical informatics

Topic 1.1 Prerequisites and basics

Subtopic 1.1.1 Use of personal information processing tools for documentation, for personal communication including Internet access, for publications and for basic statistics [IMIA: 1.4].

No.	Expertise	Level	Content & curricular notes
1.1.1.1	Students can explain and use IT methods and tools to support study and training (including flexible and distance learning) and e-learning technologies (including the Internet and World Wide Web).	2. application and analysing	This includes tools for literature management and integration in texts, such as CITAVI, as well as methods and tools for personal knowledge management (e.g. mind maps).
1.1.1.2	Students are familiar with the structure and properties of file systems and can also use network and cloud-based file systems to organise their own file storage and that of work teams.	2. application and analysing	This includes applications for distributed version management of files (example: Git).

Figure 2: Sample excerpt from the Competence catalogue for Bachelor degree programs in (Bio-)Medical Informatics and Health Information Management of the GMDS

Competences describe skills that students should or can acquire in corresponding study programs. A distinction is made between three successive competence levels based on Bloom's taxonomy [13]:

1. knowing and understanding
2. applying and analysing
3. evaluate and synthesise

Some of the competence descriptions contain supplementary **curricular information**, particularly on relevant content to be taught.

An excerpt from the competence catalogue, which demonstrates the division of the catalogue into chapters, topics, sub-topics and competences, is shown in Figure 2.

To facilitate the use of this catalogue, we have also developed a supplementary spreadsheet. Using this spreadsheet, program managers can easily report the extent to which each competency is covered by the program, automatically calculate coverage rates, and develop a graphical representation of the program's competency profile similar to the radar chart in Figure 1.

We have tested the completeness of the catalogue and the usability of the spreadsheet by analysing and comparing five programs in medical informatics from Germany and Austria. Figure 3 shows an example of the program profile for the Bachelor degree program in Health Information Management (B.Sc.) at Hochschule Hannover – University of Applied Sciences and Arts (academic year 2023/2024). Figure 4 shows the ECTS credit point (CP) profile of this program.

The full version of the catalogue is available in the supplement to this paper and in [12]. Additional instructions and the supporting spreadsheets can be downloaded here: [14].

Discussion

The catalogue of competences describes 234 competences with a focus on Bachelor programs at universities. It is now available for free for all interested universities. The catalogue was already successfully used to describe and contrast medical informatics programs at several universities in German and Austria [15].

The strength of this catalogue is its iterative development with input from experts and review of comparable work, leading to a comprehensive description of what fields should be covered in a Bachelor program. As a limitation, its development was based on consensus rounds without seeking formal consensus on all 234 competencies (e.g., in the form of a Delphi survey).

It is not intended that every study program teaches all competences at all specified levels; rather, the catalogue of competences represents a toolbox of potential competences that can be used to develop or describe the profile-specific range of competences of a study program. Overall, the following application scenarios are intended with the competence catalogue:

- As part of the development of relevant study programs, the catalogue is intended to provide support in defining the range of competencies to be taught.
- The catalogue enables the comparison of study programs, especially for prospective students and employers, by presenting the competences taught in a program-specific manner.
- The catalogue can support the accreditation of BMHIM degree programs by transparently presenting the desired competence profile by referring to the catalogue.

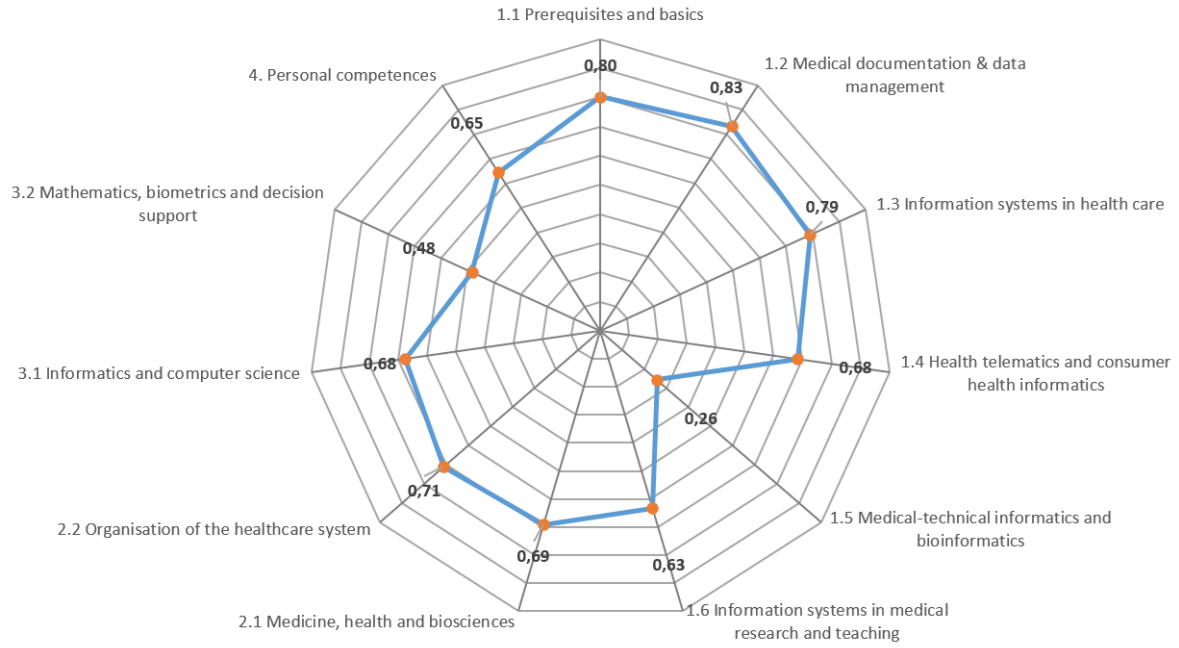

Figure 3: Example of a program profile for the Bachelor program in Health Information Management (B.Sc.) at Hochschule Hannover – University of Applied Sciences and Arts (academic year 2023/2024). The blue lines indicate the extent to which the study program addresses the competence areas described in the competence catalogue (1: all competences described in the catalogue for the competence area are taught; 0: none of the competences described in the catalogue are taught).

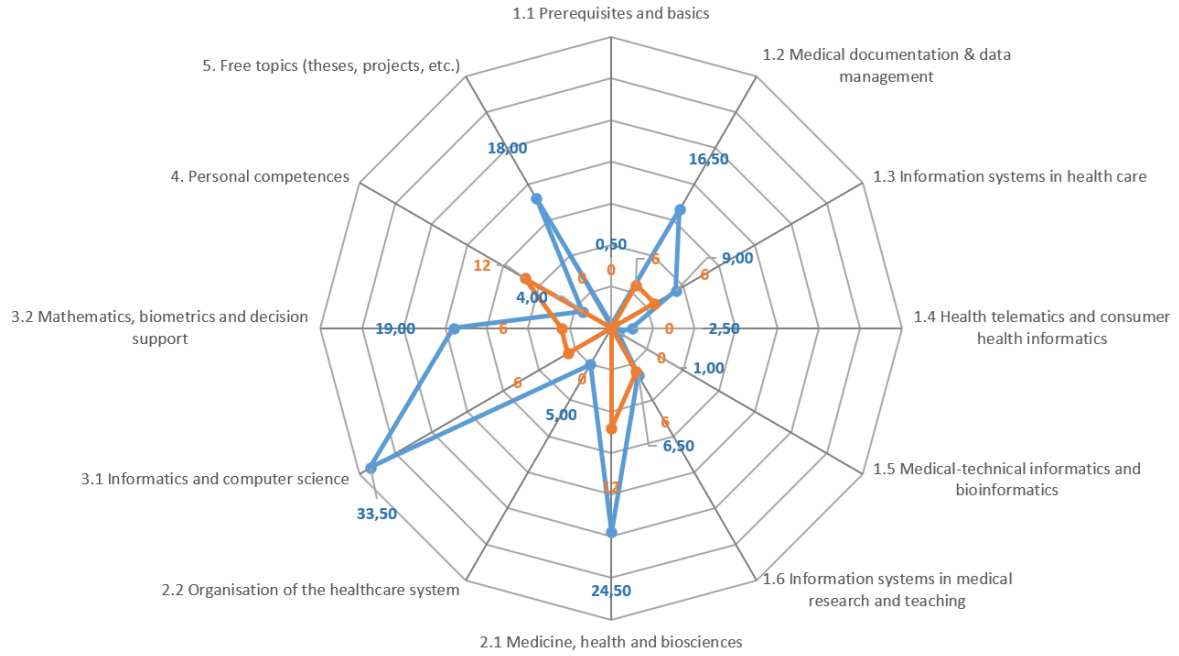

Figure 4: Example of the ECTS-CP profile of the Bachelor degree program in Health Information Management (B.Sc.) at Hochschule Hannover – University of Applied Sciences and Arts (academic year 2023/2024). The blue line indicates how many CP are provided in the compulsory program for the respective competence area, the orange line shows how many CP are offered in the compulsory elective program.

In a next step, the CMI WG will develop recommendations for selected study program profiles, each of which will specify a selection of minimum core competencies to be taught. By adding further competences from the catalogue, program-specific compilations of competences can be created that describe the particular profile of the respective degree programs.

In preparation for this step, current BMHIM study programs should first be mapped to the catalogue of competences to identify similarities and differences. For this purpose, a mapping tool was developed based on the above-mentioned spreadsheet that allows degree program profiles to be mapped to the competencies of the catalogue and to indicate the credit points invested. As a result, the skills taught and credit points invested are presented in easily comparable spider diagrams and bar charts, among other things. The method has already been tested using selected study programs [15]. The methods and tools for mapping degree program profiles to the skills catalogue and comparing them are currently being further developed with the aim of being able to map a degree program quickly and easily.

The competence catalogue is comparable with the results of similar national and international initiatives to define training recommendations. Catalogues of operationalized, competency-based learning objectives have been introduced and promoted as a prerequisite for high-quality, systematic curriculum development [15], in Germany in particular, the National Competence-Based Catalogue of Learning Objectives in Medicine (NKLM) for medical degree programs is a prominent example [16].

The development of such catalogues of competencies is time-consuming and, for reasons of sustainability, it must also be ensured that the recommendations are updated at regular intervals and that appropriate resources are available for this purpose. While many competencies described in our catalogue seem quite stable over time, the catalogue needs to be updated and extended from time to time to cover emerging topics (e.g., AI, current developments in interoperability standards and health data science) that are relevant for undergraduate education. Other working groups in the GMDS have also developed learning objectives catalogues for medicine, biometrics, epidemiology and nursing, and the CMI WG has been in exchange with these groups to discuss sustainability of the catalogues [17].

The work of the CMI working group and the visibility of the catalogue benefit considerably from the support of the scientific society GMDS. In addition to the relevant support of the scientific society, other success factors are essential for the effective provision of framework recommendations. The experiences gained in the development and dissemination of the GMDS competence catalogue of the CMI working group and four other GMDS working groups that have developed learning objectives catalogues for medicine, biometrics, epidemiology and nursing, as well as the SMITH-JET working group, have been compiled in a workshop [18].

To conclude, the catalogue and the supporting spreadsheet allow program managers to plan, describe, and compare their programs. We invite all interested program managers to contact us.

Notes

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- Prof. Dr. Jochen Bernauer, Ulm University of Applied Sciences, Ulm, Germany,
- Jörg Holstein, bvitg representative,
- Helmut Schlegel, KH-IT representative,
- all other experts involved by the mentors of the subtopics and not mentioned here.

Competing interests

The authors declare that they have no competing interests.

Dedication

This work is dedicated to Prof. Dr. Paul Schmücker (*13.03.1949 †19.03.2025), whose committed and lasting work for medical informatics has also enriched the Curricula in Medical Informatics working group since its foundation in 2015. His work has made a significant contribution to the results of the working group's work documented in this publication in particular. He will be missed.

Attachments

Available from https://doi.org/10.3205/mibe000276

1. Attachment1_mibe000276.pdf (696 KB)
   Competence Catalogue for Bachelor Degree Programs in (Bio-)Medical Informatics and Health Information Management of the German Society for Medical Informatics, Biometry and Epidemiology (GMDS). Version 1.2.

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