Deutsche Gesellschaft für Medizinische Informatik, Biometrie und Epidemiologie e.V.

Competence Catalogue for Bachelor Degree Programs in (Bio-)Medical Informatics and Health Information Management

GMDS Working Group Curricula in Medical Informatics

Version 1.2 (Date: 10/09/2021 (1.0) and 07/04/2025 (1.2) after minor editorial revision)
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Foreword

Digitalisation in the healthcare sector significantly contributes to medical care, research and education. The corresponding speciality is medical informatics, which aims to improve the structure, process and outcome of healthcare provision and medical research using modern methods and tools of information technology. The roots of this discipline in Germany go back more than 50 years, when P.L. Reichertz introduced the term in Germany in 1969 and was quick to point out the benefits of using informatics in the healthcare sector and especially for medical purposes. In Germany Medical informatics as an application-orientated informatics subject has been represented and further developed by the scientific society GMDS for many decades.

Today, there is a huge number of applications. The development of the German national telematics infrastructure with many legally regulated applications, the requirements for the use of IT in hospitals based on the Krankenhauszukunftsgesetzes (engl. Hospital Future Act, a law from 2020 to promote the digitalisation of hospitals in Germany), the wide range of medical-technical solutions, but also the diverse range and possibilities of solutions outside the legal framework have become overwhelming.

A key success factor for further digitalisation in the healthcare sector and the development of appropriate, practicable solutions is the availability of interdisciplinary specialists who are familiar with the specifics of the healthcare sector, basic medical aspects and the variety of available IT methods and tools. The current situation is characterised by a great need for specialists, and the trend is increasing.

With a view to the wide range of available study programs, but also as an orientation aid for employers, the interdisciplinary GMDS working group “Curricula of Medical Informatics“ has drawn up the present catalogue of competences for medical informaticians in a project lasting several years. The catalogue can be used to develop and compare Bachelor's degree programs on the one hand, but also supports employers in planning the professional development of career changers on the other. Using the catalogue, it is now easy to compare degree programs and qualifications. Prospective students or potential employers who have applications from graduates of a particular degree program, can use it to classify the specific skills mix in relation to the overall catalogue of possible skills.

It was important to the working group that, on the one hand, there was sufficient space for the specific aspects of the medical domain, but that computer science also had an equally important place, because only those who are IT-savvy and up to date can analyse processes, documentation and decision-making processes in the healthcare sector and then specify and develop appropriate, modern and future-oriented solutions or assess existing solutions in a qualified manner. The catalogue also includes a wide range of interdisciplinary skills that directly integrate knowledge of the symbiosis of IT and medicine or healthcare.

The GMDS Executive Committee would like to thank all those involved in the development of this catalogue of competences, who have invested a considerable amount of time in its development over the course of several years. May the catalogue of competences provide a framework for training, studies and professional orientation so that optimally qualified specialists will continue to be available in the future for a sustainable and effective healthcare system that is fit for the future.

Leipzig and Hanover in September 2021

Alfred Winter (President of the GMDS)
Oliver J. Bott (Head of AG “Curricula of Medical Informatics“)

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Introduction

At the end of 2014, the GMDS Executive Committee established the current working group “Curricula in Medical Informatics“ (CMI). The task of the CMI is to develop recommendations for curricula for university education in medical informatics and related subjects, taking into account current and future requirements from science and practice. Requirements for MI training from an international perspective or corresponding training recommendations, e.g. from the IMIA, are to be taken into account. Furthermore, three perspectives are to be included or delineated:

- Medical Informatics (MI)
- Health Information Management/Medical Documentation (MD)
- Biomedical Informatics (BI)

In line with this mandate, the CMI was staffed with representatives of university teaching 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. Federal Association Health IT).

After several years of development, this catalogue of competences for Bachelor degree courses in Medical Informatics, Health Information Management / Medical Documentation and Biomedical Informatics is the first result of the CMI's work. The competence 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, organisation of the healthcare system
    - 2.1 Medicine, health and life sciences
    - 2.2 Organisation 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

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

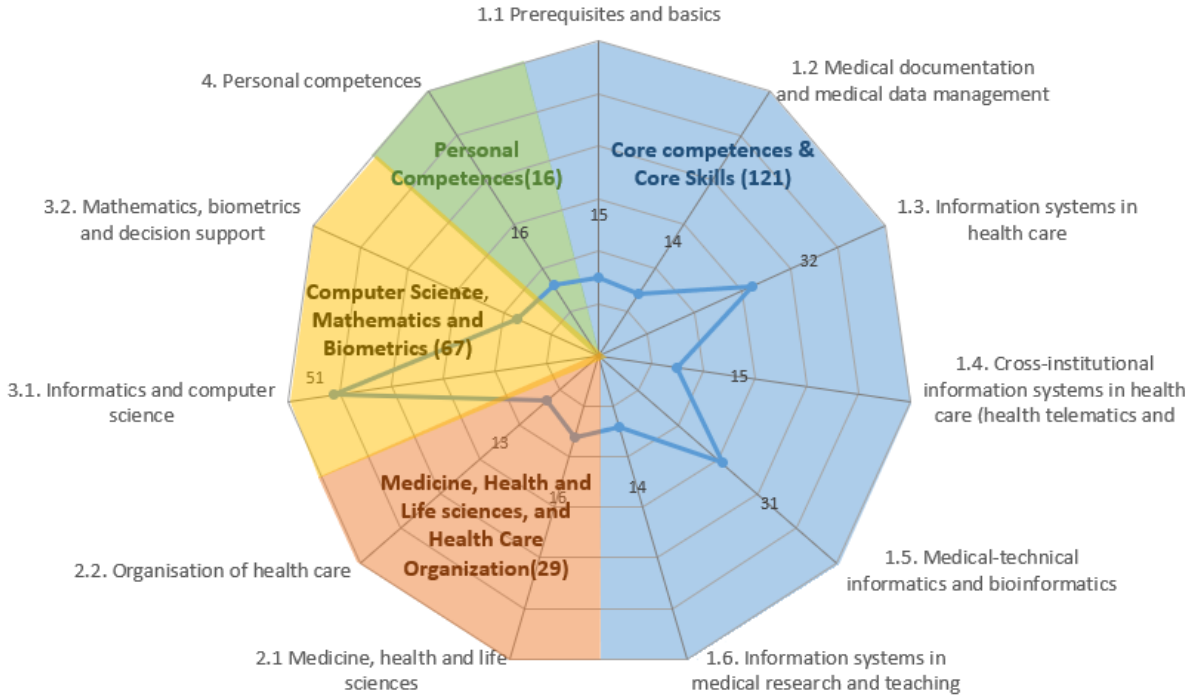

Figure 1: Chapters, subject areas and number of competences in the competence catalogue

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[1] :

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**.**

The catalogue of competences initially describes competences with a focus on Bachelor programs at universities. It is not intended that every study program teaches all competences at the specified levels; rather, the catalogue of competences represents a toolbox of potential competences that can be used to develop and/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 is intended to enable a 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 relevant degree programs by transparently presenting the desired competence profile by referring to the catalogue.

In a next step, the CMI will develop framework recommendations for selected study program profiles, each of which will specify a selection of minimum core competencies to be taught. The addition of further competences should enable program-specific compilations of competences that allow the special profile of the relevant study programs to be described.

[1] Anderson, Lorin W., and David R. Krathwohl, eds. 2001. A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. New York: Addison Wesley Longman, Inc.

This first version of the competence catalogue is to be updated regularly every 5 years as part of a governance process in the context of commenting rounds in order to be able to take up current developments such as the currently increasing importance of data science methods. Web-based tool support will be offered for these commenting phases.

In further steps, the CMI will also develop competence profiles for Master's and doctoral programs.

The competence catalogue was developed on the basis of the Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics from 2010[2], whose hierarchical structure into topics and sub-topics was the basis for the division of this competence catalogue into chapters, topics and sub-topics. References to the corresponding sections of the IMIA Recommendations can be found in square brackets in the names of the sub-topics. Once the chapters, topics and sub-topics of the competence catalogue had been defined, potential competences to be taught in a Bachelor degree program were defined at the level of the sub-topics. After completion of an initial draft version, the catalogue of competences was subjected to commentary and subsequent revision by the CMI with the involvement of external experts.

The following people are currently or have been involved in the working group and the creation of this competence catalogue and its translation:

- Prof Dr Elske Ammenwerth, UMIT in Hall/Tyrol
- Prof Dr Tim Beißbarth, University Medical Center Göttingen, coordinating representative of the field BI
- Prof Dr Oliver J. Bott, Hanover University of Applied Sciences and Arts, representative of the BVMI and coordinating representative of the field HIM
- Prof Dr Martin Haag, Heilbronn University of Applied Sciences
- Prof Dr Peter Haas, Dortmund University of Applied Sciences and Arts
- Prof Dr Anke Häber, University of Applied Sciences, Zwickau
- Prof Dr Heinz Handels, University of Lübeck
- Jörg Holstein, Managing Director of VISUS in Bochum, representative of the bvitg
- Dr Alexander März, IT department at Nuremberg Hospital, physician, representative of the KH-IT
- Dr Dominik Müller, University of Augsburg
- Prof Dr Hans-Ulrich Prokosch, University of Erlangen
- Prof Dr Matthias Schlesner, University of Augsburg
- Prof Dr Paul Schmücker, Mannheim University of Applied Sciences, coordinating representative of the field MI
- Prof Dr Cord Spreckelsen, Jena University Hospital
- Prof Dr med. Sylvia Thun, BIH@Charité Universitätsmedizin Berlin

The following supported the creation of the competency catalogue

- Experts from the SMITH-Joint Expertise Center for Teaching (*SMITH-JET*) under the direction of Prof. Dr Alfred Winter, University of Leipzig
- Helmut Schlegel, KH-IT representative

[2] Mantas, J., Ammenwerth, E., Demiris, G., Hasman, A., Haux, R., Hersh, W., Hovenga, E., Lun, K. C., Marin, H., Martin-Sanchez, F., & Wright, G. (2010). Recommendations of the international medical informatics association (IMIA) on education in biomedical and health informatics. Methods of Information in Medicine, 49(2), 105-120. https://doi.org/10.3414/ME5119

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).
1.1.1.3	Students are familiar with the structure and features of typical office application systems and can use word processing systems, presentation systems, spreadsheet systems, note systems and e-mail clients efficiently.	2. application and analysing	In particular, advanced functions of spreadsheets calculation systems with their possibilities for statistical data analysis and presentation should be mastered. With regard to word processing, the focus is on the efficient creation of larger documents (especially scientific papers).

Subtopic 1.1.2 Development of fields as a discipline and as a profession [IMIA: 1.1]

No.	Expertise	Level	Content & curricular notes
1.1.2.1	Students will be familiar with the fields of medical informatics, health information management and biomedical informatics and will be able to define and differentiate between them and name and explain the main sub-areas.	1. knowing and understanding	In the presentation and delimitation of the fields, medical documentation should be included as a cross-sectional topic of all three fields mentioned.
1.1.2.2	Students can name typical problems and tasks in the fields of (bio)medical informatics and health information management	1. knowing and understanding	

	in the context of medical care and research.		
1.1.2.3	Students can explain the historical development of the fields of (bio)medical informatics and health information management in the context of the development of medical care and research.	1. knowing and understanding	

Subtopic 1.1.3 Importance of systematic information processing in healthcare, added value respectively benefits and limitations of IT in healthcare [IMIA: 1.2].

No.	Expertise	Level	Content & curricular notes
1.1.3.1	Students can explain the importance of systematic information processing for an effective healthcare system.	1. knowing and understanding	Discussion of the use of data in healthcare and medical research with reference to specific tasks of data processing, in particular in the context of medical documentation, medical, nursing and therapeutic decision-making, quality assurance and the various facets of medical research as well as billing and support for the management of effective and efficient service provision (processes) in clinics in terms of economy, quality of results and process performance. With regard to the illustration of the expected effects of systematic information processing, reference can be made to the German BMBF's Medical Informatics Initiative from 2017 to 2026.
1.1.3.2	Students can explain how the operation and management of healthcare facilities can be supported by IT systems.	1. knowing and understanding	This competence relates to the projection of the concept of business information systems from business informatics to information systems of healthcare facilities with reference to the differentiation between, in particular, administration and scheduling systems as well as management information and planning systems. A more differentiated concretisation of the support of medical action is addressed in competence 1.1.3.3.

1.1.3.3	Students know the facets of the support of medical activities and processes by IT systems and can name limits.	1. knowing and understanding	The subdivision of the aspects of medical activities according to Haas 2004 can be used for differentiation: Information transparency, the problem-orientated medical record, clinical pathways and treatment management, notification and reminder functions, integration of literature/knowledge bases, decision support functions. A more general distinction can be made between the support dimensions (ibid.): Processing, documentation, organisation, communication, decision support.
1.1.3.4	Students can explain how medical research can be supported by IT systems.	1. knowing and understanding	Knowledge of IT infrastructure concepts and specific information system components to support medical research, especially in research networks, should be imparted. The German TMF e.V. and its affiliated initiatives should be mentioned as a relevant organisation and source of information in this field.
1.1.3.5	Students can explain the problem of semantic interoperability with reference to the structure of medical documentation and the integration of information systems in the healthcare system.	1. knowing and understanding	Importance of semantic reference systems for medical documentation, importance of standards for documentation and data exchange

Subtopic 1.1.4 Efficient and responsible use of information processing tools to support healthcare professionals and their decision-making [IMIA: 1.3].

No.	Expertise	Level	Content & curricular notes
1.1.4.1	Students can name and apply the principles of appropriate documentation and health data management (including the ability to use and set up health and medical coding systems).	2. application and analysing	
1.1.4.2	Students can name the basics of medical decision-making as well as diagnostic and therapeutic strategies and explain them using	1. knowing and understanding	

	the example of use cases/selected clinical scenarios.		
1.1.4.3	Students can name, explain and actively take into account political, regulatory and ethical framework conditions for dealing with information in the healthcare sector.	2. application and analysing	
1.1.4.4	Students will be able to plan and implement efficient and responsible use of information processing tools to support healthcare practice and decision-making by healthcare professionals.	2. application and analysing	

Topic 1.2 Medical documentation and medical data management

Sub-theme 1.2.1 Information literacy: classification systems for libraries, systematic terminologies of the health care system and their coding, methods of literature search, research methods and research paradigms [IMIA: 1.5].

No.	Expertise	Level	Content & curricular notes
1.2.1.1	Students know the basic options for acquiring literature and the principles of the rules for formal cataloguing in academic libraries. They understand how library management systems work in academic libraries. Students know the most important general and subject-relevant information resources and are able to use them when information is required. Students can analyse subject-specific problems and implement search strategies for relevant information resources.	2. application and analysing	Typology, function and areas of application of the most important forms of publication and information resources, especially in the fields of medicine and medical informatics. Formal cataloguing according to the RAK-WB. PICA as an example of a library management system. Presentation and use of selected examples. Development and targeted use of basic search strategies. Evaluation of search results. Use of a content indexing system (thesaurus or classification) when retrieving from databases. Possibilities of literature procurement.
1.2.1.2	Students know the importance of specialised databases as sources of specialised information. They have an understanding of the organisation, structure and the resulting use of specialist databases and can conduct	2. application and analysing	Organisation and structure of medical and medical informatics databases and their search options using the example of free offers on the WWW (PubMed, Open Access, Google Scholar etc.). Importance and application of content

	research in them. They understand the function of content indexing and can apply it correctly using the example of MESH for Medline/PubMed. Students know the thematic coverage and quality criteria of important medical databases on the WWW.		indexing for the search using the example of MeSH in PubMed. Basic overview of medically relevant professional and end-user orientated specialist databases.
1.2.1.3	Students are familiar with quantitative and qualitative research methods and steps in the research process.	2. application and analysing	Introduction to quantitative and qualitative research methods. Steps in the research process: gathering available knowledge, developing a research question or hypothesis, planning a study, conducting the study, analysing the data, drawing conclusions from the study, publishing the results.

Subtheme 1.2.2 Principles of documentation and data management in healthcare, including the ability to utilise medical and health-related coding systems; construction of medical and health-related coding systems [IMIA: 1.11].

No.	Expertise	Level	Content & curricular notes
1.2.2.1	Students know and understand the basic terms and concepts of documentation and organisation theory as well as information retrieval.	1. knowing and understanding	Procedure of the documentation process with the focus on formal and content-related indexing.
1.2.2.2	Students are familiar with the basic principles and legal framework of medical documentation. They are able to implement these in practice using typical documentation systems. They know and understand the structure of typical medical documentation.	2. application and analysing	Aim and tasks of medical documentation and documentary principles. Importance of structured/standardised documentation for science, healthcare, administration and billing. Converting medical facts into a suitable form of documentation. Typical medical documentation: Medical records, medical record archives, basic clinical documentation, documentation of findings, clinical tumour documentation, documentation for quality management, clinical and epidemic registers, documentation for

			clinical studies. Register, documentation for clinical studies.
1.2.2.3	Students will be able to select or design the appropriate documentation system for a given medical documentation task and create or configure the database basis of the documentation system professionally. They know and understand the methods of structured data acquisition.	3. evaluating and synthesising	Criteria for selecting suitable documentation systems, systematic selection and configuration of a documentation system, data models for documentation systems, database modelling of examples of clinical documentation (e.g. diagnoses, laboratory data, procedures, patient master data, therapy documentation)
1.2.2.4	Students know and understand the basic concepts of general terminology theory and the importance of terminological systems for medical documentation. They know and understand the content, structure and area of application of the most important medical classification and terminology systems and can apply selected medical terminology systems in practice.	2. application and analysing	Nomenclatures, vocabularies, terminologies, ontologies and taxonomies of biomedical informatics. Examples: ICD, OPS and DRG as well as the thesaurus MeSH (Medical Subject Headings), the UMLS and further classification systems (e.g. TNM, MedDRA and AO classification) and nomenclatures (SNOMED). Data models of medical terminology systems.

Subtopic 1.2.3 Principles of data representation and data analysis from primary and secondary sources, data mining, data warehouses and knowledge management [IMIA: 1.14]

No.	Expertise	Level	Content & curricular notes
1.2.3.1	Students know the basic concepts of database technology and development and understand their significance for medical information and documentation systems. They know the most important description methods for data models and can use at least the ER technique for data modelling. They are able to systematically transfer an ER data model into a database schema. They can formulate simple database queries (relational algebra, SQL).	2. application and analysing	Databases (introduction and overview). Database design, ER modelling, UML. The relational model and relational query languages. Data integrity and relational design theory. Project phases of creating a database.

1.2.3.2	Students know the principles of object-oriented analysis and data modelling as well as the Unified Modelling Language and can apply them. They can transfer a problem area into an object-oriented data model.	2. application and analysing	Introduction to object-oriented analysis and modelling, in particular with UML: classes, objects, methods, inheritance, polymorphism.
1.2.3.3	Students master the theoretical principles required for the professional use of XML. They are able to create, search and edit XML files with the appropriate tools.	2. application and analysing	Structure and rules of XML. XML schema for structure description. XPath and XQuery for content queries. XSLT for visualisation. XML serialisation of RDF. XSLT for visualisation.
1.2.3.4	Students know the most important concepts of the Semantic Web and are able to model simple facts in the XML-based languages of the Semantic Web.	2. application and analysing	Basics of the Semantic Web. Thesauri, topic maps and ontologies. Languages of the semantic web: RDF, RDF/XML, RDFS and OWL.
1.2.3.5	Students are familiar with application scenarios and architectural concepts of data warehouses, the data model, storage and query realisation in a data warehouse and can work on typical issues in data warehouses, i.e. design and operate data warehouses.	2. application and analysing	Architecture and application scenarios of data warehouses (DWH). Modelling of DWH (multidimensional modelling, OLAP operations) and implementation. Extraction, Transformation Load (ETL) processes. Queries and optimisation.
1.2.3.6	Students are familiar with the most important data mining methods for extracting information from structured and unstructured data and can apply these independently to typical questions in the field of application.	2. application and analysing	Introduction with application scenarios for typical data mining tasks: classification, segmentation, dependency and deviation analyses, time series analyses/forecasts. Reference to relevant machine learning methods and preparatory data cleansing.
1.2.3.7	Students are familiar with basic models of knowledge management. They can describe the importance of knowledge management for the success of a company and select and design targeted knowledge management methods in application scenarios.	2. application and analysing	Introduction to knowledge management (motivation, importance, building blocks). Forms of knowledge (concept of knowledge, knowledge and action, knowledge and ability, maturity levels, knowledge ladder). Availability of knowledge (SECI model, story-telling, knowledge spiral; knowledge creation; knowledge loss). Value of

			knowledge (corporate value, intellectual capital, knowledge measurement, intellectual capital statement). Knowledge networking (social networks, internal networks, cross-organisational networks).

Topic 1.3 Information systems in medical care

Subtopic 1.3.1 Features, functionalities and examples of application systems in healthcare (e.g. application systems for hospitals, medical practices, rehabilitation and care as well as for patients) [IMIA: 1.6]

No.	Expertise	Level	Content & curricular notes
1.3.1.1	Students know important types of application systems in the outpatient and inpatient sector as well as in the area of public care and can describe which business tasks they support in each case.	1. knowing and understanding	Patient administration systems, clinical application systems (e.g. KAS, LIS, PIS, RIS, PACS, CPOE, archive, operating theatre, application systems for facility management and logistics (pharmacy, blood bank, warehouse, food supply, etc.) and general administration systems (e.g. application systems for financial accounting, controlling, revenue assurance, human resources).
1.3.1.2	Students can describe the typical functionality and user group for important types of application systems.	1. knowing and understanding	
1.3.1.3	Students can explain how different application systems work together to support information logistics in a healthcare organisation.	1. knowing and understanding	End-to-end process support
1.3.1.4	Students can identify and correctly name the application systems used in a specific example of a healthcare facility.	2. application and analysing	
1.3.1.5	Students know the tasks of IT risk management and can name the associated standards.	2. application and analysing	B3S, ISO 31000, ISO/IEC 20000-1, ISO 27005

Subtopic 1.3.2 Architectures of healthcare information systems; approaches and standards for communication and interoperability (HL7, DICOM, IHE, ...) as well as for interface and integration concepts in the context of component-based architecture paradigms (e.g. service-orientated architectures) [IMIA: 1.7].

No.	Expertise	Level	Content & curricular notes
1.3.2.1	Students are familiar with the most important communication and interoperability standards in the context of healthcare information systems and understand the basic structure of these standards and their suitability for various communication processes.	1. knowing and understanding	Important examples are HL7 with HL 7 version 2.x, version 3 (in particular CDA) as well as FHIR, IHE, openEHR, ISO 13606, DICOM and the German xDT standards for the outpatient sector. A link must be established to standards for semantic reference systems (e.g. SNOMED-CT, LOINC, ICD etc.).
1.3.2.2	Students know the importance of communication servers for message-based communication and their tasks and central functions.	1. knowing and understanding	Definition of the term communication server, typical tasks and functions, configuration, application functions, extended functions, especially in the context of data warehouses
1.3.2.3	Students can use a given communication standard to exchange information between sender and receiver.	2. application and analysing	For example, the use of HL 7 version 2.x for the transfer of a discharge notification to subsystems of a HIS in the context of a self-programmed simulation or laboratory environment. Or the use of FHIR to retrieve patient data.
1.3.2.4	Students are familiar with the various architectural forms of hospital information systems and their advantages and disadvantages and can explain these using a specific example.	2. application and analysing	Star architecture, spaghetti architecture; best of breed, all in one
1.3.2.5	Students are familiar with various integration requirements in hospital information systems and can use a specific example to describe the extent to which these are fulfilled and what the consequences are if they are not fulfilled.	3. evaluating and synthesising	Data integration, semantic integration, context integration, etc.
1.3.2.6	Students are familiar with the problem of unique patient identification and possible solutions in distributed systems.	2. application and analysing	The basic problem of unique patient identification, options for defining patient identifiers, advantages and disadvantages of semantic keys, need for a master

			patient index, the IHE/PIX profile, analysing and cleansing databases (merging patient data, separating patient data), use of the eGK for unique identification/lifelong insurance number

Subtopic 1.3.3 Management of healthcare information systems (management of health information, strategic and tactical information management, IT governance, IT service management, legal and regulatory aspects) [IMIA: 1.8]

No.	Expertise	Level	Content & curricular notes
1.3.3.1	Students can describe and differentiate between the tasks of strategic, tactical and operational management of information systems.	1. knowing and understanding	Information management, information logistics
1.3.3.2	Students can describe the purpose and structure of an IT strategy and explain it using a specific example and also show how the IT strategy is linked to the corporate strategy in terms of IT governance.	1. knowing and understanding	Discuss concrete IT strategy and its subdivision. Also address IT compliance with reference to the IT strategy, e.g. licence management
1.3.3.3	Students can provide an overview of the purpose and content of important norms and standards in the area of IT management in healthcare facilities.	1. knowing and understanding	COBIT, ITIL, Prince2, ISO27001, BSI, ISO/IEC 38500, ISO/IE 20000
1.3.3.4	Students can describe what organisational structures for IT management can look like and what their advantages and disadvantages are.	2. application and analysing	
1.3.3.5	Students can outline and justify an IT strategy for a selected organisational unit.	3. evaluating and synthesising	e.g. for a clinic: current status, evaluation, target status, project proposals

Subtheme 1.3.4 Socio-organisational and socio-technical aspects including process and system analyses, process modelling, process design, process reorganisation [IMIA: 1.13]

No.	Expertise	Level	Content & curricular notes
1.3.4.1	Students can explain why information systems are socio-technical systems and what this means for IT management.	1. knowing and understanding	Importance of process management, usability/HCI

1.3.4.2	Students know methods for analysing systems and are able to use these in a targeted manner in a clinical environment.	2. application and analysing	Observations, written surveys, oral interviews, data analysis
1.3.4.3	Students know a notation for business process modelling and are able to model a clinical process in a comprehensible way.	2. application and analysing	BPMN, UML, EPK ...
1.3.4.4	Students can evaluate a modelled clinical process using suitable evaluation methods and then reorganise it in a targeted manner.	3. evaluating and synthesising	

Subtopic 1.3.5 Ethical issues and importance of information security including responsibilities of clinical staff, management and BMI specialists and aspects of confidentiality, privacy and security of patient data

No.	Expertise	Level	Content & curricular notes
1.3.5.1	Students know the concept of information security and can define the various aspects of information security and explain them using examples.	1. knowing and understanding	Confidentiality, availability, integrity,…
1.3.5.2	Students understand the need to protect sensitive data and can explain both the objectives and measures of data protection.	1. knowing and understanding	Role of MI!
1.3.5.3	Students can outline norms, standards and legal foundations of information security and data protection.	1. knowing and understanding	ISO27001, BSI, ...
1.3.5.4	Students can describe which aspects of information security have been breached in a specific situation and what impact this can have on patient care.	2. application and analysing	
1.3.5.5	Students can explain which groups of people are responsible for different aspects of information security.	2. application and analysing	

Subtopic 1.3.6 Evaluation and assessment of information systems, including study design, selection and triangulation of (quantitative and qualitative) methods, evaluation of outcome and impact, economic evaluation, adverse effects

No.	Expertise	Level	Content & curricular notes
1.3.6.1	Students understand the need to systematically evaluate information systems in terms of effectiveness and efficiency as well as undesirable effects.	1. knowing and understanding	
1.3.6.2	Students are able to formulate and justify the objectives and questions of an evaluation in a given situation.	2. application and analysing	
1.3.6.3	Students are familiar with key quantitative and qualitative methods of data collection and data analysis as well as typical study designs for evaluation studies.	1. knowing and understanding	
1.3.6.4	Students know the essential steps of an evaluation study and are able to draw up an evaluation plan.	2. application and analysing	
1.3.6.5	Students are able to search for evaluation studies via literature research and critically assess their results and quality.	3. evaluating and synthesising	

Subtopic 1.3.7 Systematic reviews and meta-analyses, evidence-based medical informatics [IMIA: 1.19]

No.	Expertise	Level	Content & curricular notes
1.3.7.1	Students can describe the purpose and structure of systematic reviews and meta-analyses and understand their necessity as the basis of evidence-based medical informatics.	1. knowing and understanding	
1.3.7.2	Students can search for systematic reviews and meta-analyses on a given question and critically assess their conclusions.	2. application and analysing	

Topic 1.4 Cross-institutional information systems in medical care (health telematics and consumer health informatics)

Subtheme 1.4.1 Methods and approaches for regional networking and integrated care (eHealth, telematics applications in the healthcare system, health telematics platforms, cross-institutional information exchange, health services research) [IMIA: 1.10]

No.	Expertise	Level	Content & curricular notes
1.4.1.1	Students know the main challenges in health care and the motivation and value contribution of telematics solutions, they know the essential interaction scenarios and are able to categorise existing IT-based solution approaches using an application taxonomy.	1. knowing and understanding	Current problems such as demographic development, sectorisation of care; complexity of cross-institutional processes, interaction scenarios in the healthcare system; value contribution through networking and support in the five different support dimensions processing, documentation, communication, organisation and decision support; application taxonomy with three classes: care, teaching and training, research; web services as integration technology
1.4.1.2	Students know the most important aspects and solution approaches for distributed information systems and understand, how information systems work together and at which levels integration must take place and can analyse and design interoperability approaches.	2. application and analysing	Integration levels: the five OPD viewpoints, the levels of integration: technical integration / data integration / semantic integration / function integration / presentation integration / business process integration
1.4.1.3	Students know the legal regulations for the development of the national telematics infrastructure and its applications.	1. knowing and understanding	Regulations in German SGB V, role of national agency gematik, national applications i.e. VSDM, medication plan, emergency data set, electronic patient record system, KIM, role of cards, security infrastructure in accordance with national legislation
1.4.1.4	Students are familiar with the main components/systems of a health telematics platform and existing standards for this, as well as the elements of the planned national telematics infrastructure (TI) in Germany.	1. knowing and understanding	Elements of the governance infrastructure, the technology infrastructure, the security infrastructure and the application infrastructure, terminology server, Health Provider Directory and IHE profiles, the role of OIDs, the TI components

			connector/eGK/HBA/networks and interaction using the examples of VSDM and emergency data
1.4.1.5	Students are familiar with CDA-based medical reports and its possibilities for the cross-institutional communication and can evaluate, plan and implement report communication solutions.	3. evaluating and synthesising	CDA-based reports in general, special benefit for transmitting findings, processing steps in the sending and receiving system, software-based parsing of reports for data use in the receiving system, procedure for designing new communications based on the CDA-based reports, user aspects in the primary systems of the providers
1.4.1.6	Students recognise the potential for health services research and a learning healthcare system.	1. knowing and understanding	Health services research and health services data, basic structure of telematics solutions for health services research, the role of medical registers, the concept of a learning healthcare system, interoperability requirements for data collections for health services research and a learning healthcare system

Subtopic 1.4.2 Structure, design and analysis principles for health records including the concepts of data quality, minimum data set, architecture and general applications of electronic patient and health records [IMIA: 1.12].

No.	Expertise	Level	Content & curricular notes
1.4.2.1	Students know the objectives of cross-facility patient records and the value contribution in contrast to pure point-2-point doctor's reports communication, they know different patient record types and their characteristics and categorisation criteria in detail and can outline solution approaches for given problems.	1. knowing and understanding	Difference between institutional and cross-institutional electronic patient records, cross-institutional record types: Case records, doctor-managed patient records, patient-managed health records, emergency data and patient summary record, register records and integrative approaches. Basic interaction of primary IT-systems and patient record systems using a case study.
1.4.2.2	Students know the difference between document-based patient record systems and granular phenomenon-based record	2. application and analysing	Principle paradigm, resulting basic data models, IHE/XDS, ISO 13606, openEHR, the role of FHIR for record interoperability

	systems as well as standards for the paradigms.		
1.4.2.3	Students know the various aspects that need to be considered when using cross-facility record systems and what this means for interoperability between record systems and primary IT-systems of the providers and can analyse and design solutions with regard to these aspects.	3. evaluating and synthesising	Information structuring and semantics, content strategy, information synchronisation, interoperability, functionalities for various purposes, data protection aspects in general and aspects of rights management in particular
1.4.2.4	Students are familiar with the use and value contribution of record systems for various care scenarios, integration of telemonitoring into patient record systems.	2. application and analysing	Specific care scenarios and use of record systems: dementia care, geriatric care, palliative care, monitoring and care of coronary disease patients, psychiatric care
1.4.2.5	Students are familiar with advanced application aspects and scenarios using electronic patient record systems.	1. knowing and understanding	Record systems as the basis for treatment management, cross-facility clinical pathways and treatment management, team-orientated action by different professional groups, problem-orientated medical record according to Weed, patient record as the basis for decision-support mechanisms

Subtopic 1.4.3 Characteristics, functionalities and examples of information systems to support patients and the population (e.g. architecture and application of patient-centred information systems, personal health records, sensor-based information systems, health apps) [IMIA: 1.9].

No.	Expertise	Level	Content & curricular notes
1.4.3.1	Students are familiar with current trends and the changes in roles in the healthcare system due to the use of IT as well as the basic support options for patients.	1. knowing and understanding	Stages of illness and patient needs, patient sovereignty and self-management, the role of IT in the patient-doctor relationship, health literacy applications, positive and critical aspects of a new distribution of roles, virtual patient communities/forums
1.4.3.2	Students know the basic functionalities of record systems for patients and can analyse solutions for the support of patients.	2. application and analysing	Patient Self-documentation, self-organisation, electronic communication with treatment team members, context-sensitive literacy research and management, example OpenNotes from Harvard University

1.4.3.3	Students know the objectives, functionality and various implementation options of health apps and interoperability of apps and record systems.	2. application and analysing	Health apps and health behaviour, basic characteristics (purely local, local with background system, central as web app), data protection aspects, taxonomy of health apps, application examples e.g. diabetes, obesity, medication management
1.4.3.4	Students are familiar with the basic model for telemonitoring and the use and integration of sensors for various purposes.	1. knowing and understanding	Principle models for telemonitoring according to VDI, interoperability of sensors and apps or background systems, sensor technologies, integrative application example AAL

Topic 1.5 Medical-technical informatics and bioinformatics

Subtopic 1.5.1 Bioinformatics and systems medicine (incl. biomedical modelling and simulation) [IMIA: 1.15 with supplement].

No.	Expertise	Level	Content & curricular notes
1.5.1.1	Data management in bioinformatics	1. knowing and understanding	1. public molecular biology resources and databases 2. structuring of biomedical knowledge 3. integration of biological and medical background knowledge
1.5.1.2	Sequence analysis	2. application and analysing	1. alignment 2. sequence database search 3. phylogeny
1.5.1.3	Molecular structures and pathways	1. knowing and understanding	1. protein 3D structure modelling 2. RNA structures 3. molecular networks and pathways 4. function prediction
1.5.1.4	Analysing high-throughput data (omics)	3. evaluating and synthesising	1. basic statistical analyses (descriptive, linear regression, ANOVA) 2. visualisation of high-dimensional data (heatmap, Vulcano plot, distributions) 3. classification and prediction (therapy response, survival, clinical endpoints)

1.5.1.5	Systems modelling	2. application and analysing	1. systems biology and modelling of biological and medical processes 2. systems medicine and implementation of systems models in clinical research and routine practice

Subtopic 1.5.2 Biomedical image and signal processing [IMIA: 4.1]

No.	Expertise	Level	Content & curricular notes
1.5.2.1	Students are able to classify and characterise basic procedures for medical image processing.	1. knowing and understanding	Point operators (histogram operations etc.), local operators (edge and smoothing filters), segmentation methods: Threshold-based segmentation and region growing, morphological operators, rigid and affine registration, quantitative analysis of image data (distance and angle measurement, ROI analysis, etc.)
1.5.2.2	They are able to differentiate between various methods of segmentation, cluster analysis and statistical pattern recognition and characterise them based on the implicitly used, different model assumptions and properties. They are able to use these methods to segment medical multispectral image data and to recognise objects.	2. application and analysing	Region growing, threshold-based segmentation, cluster analysis and classifiers for image segmentation: K-Means method, Bayesian classification, ML classification, Euclidean and Mahalanobis classifier, K-NN classification
1.5.2.3	Students can evaluate the segmentation results of different methods using established quality measures and carry out an objective comparison of the quality of different segmentation methods in practical application.	2. application and analysing	Quality measures: Dice coefficient, Hausdorff distance, mean contour and surface distance, etc.
1.5.2.4	They are able to assess the properties of rigid and affine image registration methods and to select and parameterise similarity measures and regularisation terms for a specific registration problem.	2. application and analysing	Feature space, similarity measure (SSD, mutual information), search space
1.5.2.5	Students can implement basic image processing algorithms and use them in combination with	2. application and analysing	Point operators (histogram operations etc.), local operators (edge and smoothing filters),

	medical image processing modules available in a software library.		segmentation methods: Threshold-based segmentation and region growing, morphological operators, rigid and affine registration, quantitative analysis of image data
1.5.2.6	They have the ability to develop problem-adequate medical image analysis systems using various software tools. They will be able to analyse complex tasks, divide them into subtasks and implement them collaboratively.	2. application and analysing	E.g. with MatLab, ITK or VTK

Subtopic 1.5.3 IT-supported medical technology procedures (X-ray, CT, MR, angiography, sonography, scintigraphy, endoscopy, TEE/TTE, neurophysiology (EEG, NLG, EMG))

No.	Expertise	Level	Content & curricular notes
1.5.3.1	Students are familiar with the most important imaging procedures in radiological and nuclear medicine diagnostics as well as sonography and endoscopy, their basic technical principles, their typical range of indications and the resulting data formats and processing methods.	1. knowing and understanding	Digital radiography, CT, MRI, angiography, etc., functional diagnostics: scintigraphy, PET-CT, etc., DICOM standard Sonography and special procedures such as high-frequency sonography, Doppler sonography, TTE (transthoracic echocardiography) and TEE-transoesophageal (swallowing echo) Endoscopy and special procedures such as capsule endoscopy, double balloon endoscopy, etc.
1.5.3.2	Students are familiar with the most important diagnostic procedures in neurophysiology, their basic technical principles, their typical range of indications and the resulting data formats and processing methods.	1. knowing and understanding	EEG, NLG, EMG etc.
1.5.3.3	Students know the essential standards and standardisation initiatives in the context of imaging and signal-processing diagnostics and are able to apply them.	2. application and analysing	DICOM, IHE, etc.
1.5.3.4	Students are familiar with the key requirements arising from the Medical Devices Act and the	1. knowing and understanding	MPG (Medizinproduktegesetz: German medical device regulation), risk management,

	European Medical Device Regulation for the development of medical devices.		authorisation procedures and regulatory authorities
1.5.3.5	Students can analyse and present signal data and assess it in terms of quality and content information. They are able to identify relevant information in the data.	2. application and analysing	The pragmatic reference is the recognition of anomalies in the set of signals as the basis for diagnostics.
1.5.3.6	Students can practically apply the basic principles of medical device design in test environments.	2. application and analysing	
1.5.3.7	Students can develop simple sensor-based measurement systems for recording biosignal data. They are conceptually able to set up a medical device development project in accordance with the provisions and requirements of the Medical Devices Act.	3. evaluating and synthesising	

Subtopic 1.5.4 Integration of medical technology in healthcare information systems

No.	Expertise	Level	Content & curricular notes
1.5.4.1	Students know the typical technical integration and architecture concepts for medical devices in healthcare information systems.	1. knowing and understanding	Integration in HIS, KAS, PDMS etc. via communication server and transmission standards if necessary.
1.5.4.2	Students know the typical data transmission standards and semantic reference systems for the integration of medical devices and can apply them.	2. application and analysing	HL7, DICOM, GDT, SNOMED, LOINC, OID, UCUM, IHE etc.
1.5.4.3	Students know how a communication server works and can configure it for integration tasks.	2. application and analysing	
1.5.4.4	Students know the organisational and regulatory requirements for the integration of medical devices in the area of responsibility, technology, organisation, work processes/operation and safety and can set up an integration project.	3. evaluating and synthesising	MPG (Medizinproduktegesetz: German medical device regulation), operator responsibility, risk management (ISO 80001-1), etc.

Subopic 1.5.5 Healthcare assistive technologies, ubiquitous computing, ambient assisted living [IMIA 4.3]

No.	Expertise	Level	Content & curricular notes
1.5.5.1	Students explain the legal aspects of health-supporting technology in terms of the Medical Device Regulation and data protection legislation and categorise planned projects in terms of regulatory requirements.	1. knowing and understanding	EU Medical Device Regulation; software as a medical device and classification of health assistive technologies into product classes; EU General Data Protection Regulation and opening clauses for national legislation; data protection impact assessment and technical and organisational measures (TOMs) for data protection and data security in the context of health assistive technologies, ubiquitous computing and AAL
1.5.5.2	Students can integrate stationary, mobile and wearable sensors into information systems via interfaces and evaluate the quality of the data stream.	2. application and analysing	Sensor types and basic functional principles; sensor-related data formats, interfaces and communication standards (including MQTT/MQTT-SN, SSI); sources and frequency of signal interference; algorithmic detection and classification of signal anomalies; Internet of Things (IoT) standards
1.5.5.3	Students explain the definition, application scenarios and technical approaches for Ambient Assisted Living (AAL) and AAL systems (AALS).	1. knowing and understanding	Smart home paradigm; real-time monitoring of environments; activity modelling and activity recognition; identification of critical situations (e.g. fall detection); telemedical health monitoring;
1.5.5.4	The students explain approaches for managing and analysing large real-time data streams.	1. knowing and understanding	Ring storage solutions; smart grids, open gateway platforms (OSGi); complex event processing; architectures (including Lambda Architecture)
1.5.5.5	Students justify the relevance of interprofessionalism and the need for and challenges of intersectoral communication.	3. evaluating and synthesising	Geriatric care structures; cross-sector care processes; technical aspects of intersectoral communication, in particular different data communication standards (xDT vs. HL7 standards)

Subtopic 1.5.6 Medical robotics and computer-assisted surgery [partially from IMIA 4.7]

No.	Expertise	Level	Content & curricular notes
1.5.6.1	Students can provide an overview of robotic systems currently used in medicine and explain typical disease profiles and care scenarios and their respective treatment or support by robotic systems.	1. knowing and understanding	Robots in surgery, care, etc.
1.5.6.2	Students know the special requirements of the environment and the system for a robot-assisted operation and can name the conditions for a robot-assisted operation and the necessary preparatory measures.	1. knowing and understanding	Equipment, operating theatre setting, team aspects, regulatory requirements, etc.
1.5.6.3	Students can explain the use of a robotic system in the operating theatre using typical scenarios and are able to design corresponding workflows for a robot-assisted procedure.	2. application and analysing	
1.5.6.4	Students know the technical aspects of using a robot system and can apply these to the development of robot-based systems.	2. application and analysing	Kinematics, tracking systems, collision detection and avoidance, basic procedures for the registration of image data from different modalities and physical registration with its various flexibilisation levels

Topic 1.6 Information systems in medical research and teaching

Subtopic 1.6.1 Features, functionalities and examples of information systems to support clinical research (e.g. clinical trials, clinical registries, data integration centres)

No.	Expertise	Level	Content & curricular notes
1.6.1.1	Students know the essential data-related business processes of clinical research, from the collection of data at the study centres to verification and validation and the preparation of data for biostatistical analysis. They are familiar with laws, regulations and standards that define the national and international requirements for	1. knowing and understanding	Basic knowledge of GCP/GEP, data collection principles and data structures; knowledge of the “Good Clinical Data Management Practices“ (GCDMP) of the Society for Clinical Data Management. Knowledge of study planning and the creation of data management plans.

	data management in clinical research projects.		
1.6.1.2	Students can name the relevant classes of specialised software systems for clinical research and understand their purpose. They know the main data exchange standards for clinical research and understand their scope of description. They know and understand the architectural concepts of data integration centres and the relevant basic technologies.	1. knowing and understanding	Electronic data capturing (EDC), creation of electronic case report forms (eCRF), clinical trial management systems (CTMS), clinical data management systems (CDMS), document management systems (DMS), drug safety systems (DSS), radomisation systems, ePRO systems (Patient Reported Outcome), metadata repositories, clinical data warehouses; architectures of data integration centres; CDISC standards (SDTM, ODM etc.)
1.6.1.3	Students can describe the steps of the implementation phase in clinical data management in detail. They can plan, implement and carry out data entry and verification as well as data import and validation using the relevant specialised software.	2. application and analysing	Conducting an example study with a CDMS, methods of data collection and quality control based on the design of eCRFs or clinical database models, validation of clinical database models, query process, medical coding, tasks/professional profiles of a clinical data manager.
1.6.1.4	Students know the task and structure of the various medical registers, they know the requirements for software systems for medical registers and understand their purpose.	1. knowing and understanding	Public health registers, health services research registers, epidemiological registers, clinical registers, cancer registers, pharmacovigilance registers, quality registers, etc. Software systems for registries.

Subtopic 1.6.2 Methods and tools of computer science to support teaching (including distance learning), use of relevant teaching technologies including the Internet and WWW

No.	Expertise	Level	Content & curricular notes
1.6.2.1	Students know the fundamental terms of technology-supported teaching and learning such as MOOC, learning management system, gamification or serious games for health and know when these concepts or tools can be used beneficially for training, education or therapy.	1. knowing and understanding	

1.6.2.2	Students know what must be observed with regard to copyright when creating teaching/learning software or educational material and which exceptions apply to research and teaching.	1. knowing and understanding	
1.6.2.3	Students know the basic forms of technology-supported teaching and learning and are able to create hypertexts using HTML.	2. application and analysing	
1.6.2.4	Students can create lecture recordings and make them available on the internet or intranet.	2. application and analysing	
1.6.2.5	Students are able to independently research and acquire new knowledge from the Internet and in relevant literature databases (ability for lifelong learning).	3. evaluating and synthesising	Possibly in another chapter (overarching topic). However, I have put it here, so it does not get lost.

Subtopic 1.6.3 Provision of and access to medical knowledge

No.	Expertise	Level	Content & curricular notes
1.6.3.1	Students can outline and explain relevant phase models of knowledge management.	1. knowing and understanding	Nonaka-Takeuchi cycle, McElroy cycle, Wiig cycle
1.6.3.2	Students know and use relevant sources in order to gain systematic access to knowledge.	2. application and analysing	Institutional sources (e.g. PubMed, NGCH/AWMF, RKI); keyword vs. keyword search; query syntax of relevant sources; relevant application programming interfaces (e.g. NCBI APIs)
1.6.3.3	Students will be able to explain and apply methods of semantic indexing of knowledge and transfer the necessary associated skills from the context of medical documentation and terminology work.	1. knowing and understanding	Role of terminology systems and classifications in the indexing of content. Implementation and use of metadata repositories and ontologies; Semantic Web techniques (RDF, SPARQL)
1.6.3.4	Students can describe relevant approaches to quality assurance of (internet) sources for health information and use them for their own evaluation.	2. application and analysing	Criteria and application framework of HON, afgis; DISCERN instrument; Fact Sheets and Fact Boxes; Institutional and organisational infrastructure

1.6.3.5	Students can explain measures of retrieval quality and use them for evaluation.	2. application and analysing	Recall, Precision, Accuracy, True negative rate, F-Measures

Chapter 2: Competences in medicine, health and life sciences, organisation of the healthcare system

Topic 2.1 Medicine, health and life sciences

Subtopic 2.1.1 Fundamentals of the functioning of the human body (anatomy, physiology, microbiology, genetics, clinical specialities such as internal medicine, surgery, etc.) [IMIA: 2.1].

No.	Expertise	Level	Content & curricular notes
2.1.1.1	Students know the basics of human anatomy, pathology, pharmacology and physiology.	1. knowing and understanding	Fundamentals of human anatomy, pathology, histology, physiology and pharmacology
2.1.1.2	Students know the basics of microbiology, laboratory medicine and human genetics.	1. knowing and understanding	Incl. LOINC, Snomed CT, ICD-10
2.1.1.3	Students can apply the findings from the basic subjects in the clinical subjects (surgery, internal medicine, gynaecology) (diagnostics and therapy) and analyse the IT requirements.	2. application and analysing	Create catalogues of requirements for clinical IT.
2.1.1.4	Students can apply and evaluate the findings from the basic subjects in special clinical fields (psychiatry, neurology, anaesthesia, radiology, dermatology...) and analyse the requirements for IT.	3. evaluating and synthesising	Create catalogues of requirements for clinical IT.

Subtopic 2.1.2 Fundamentals of health from a physiological, sociological, psychological, nutritional, emotional, environmental, cultural, spiritual perspective and their evaluation [IMIA: 2.2].

No.	Expertise	Level	Content & curricular notes
2.1.2.1	Students know the basics of health from physiological, sociological, nutritional, environmental, cultural and spiritual perspectives.	1. knowing and understanding	
2.1.2.2	Students can analyse the requirements of IT on the basis of physiological, sociological, nutritional, environmental, cultural and spiritual perspectives.	2. application and analysing	

Subtopic 2.1.3 Fundamentals of clinical and medical decision-making as well as diagnostic and therapeutic strategies [IMIA: 2.3].

No.	Expertise	Level	Content & curricular notes
2.1.3.1	Students are aware of the regulatory frameworks of the pharmaceutical industry and the IT systems that play a role in it. They know the key players and are aware of the important role played by drug information systems and testing in the e-health environment.	1. knowing and understanding	Regulatory requirements: Regulatory requirements for ePharma. ePrescription, medication plan, drug therapy safety (AMTS)
2.1.3.2	Able to apply formal decision-making languages and mechanisms.	2. application and analysing	ARDEN Syntax, Data analytics with Snomed CT, Big Data
2.1.3.3	Students can evaluate and synthesise large amounts of data.	3. evaluating and synthesising	

Subtopic 2.1.4 Overview of important diagnostic and interventional procedures

No.	Expertise	Level	Content & curricular notes
2.1.4.1	Students gain knowledge and insights into the important routine medical-technical procedures. They are familiarised with the areas of application of the usual examination procedures in acute medicine.	1. knowing and understanding	MRI, CT, radiotherapy, nuclear medicine, X-ray, ultrasound, endoscopy, laboratory, ECG
2.1.4.2	Students know the function and benefits of medical diagnostic and therapy devices (sensor technology, interfaces) as well as the underlying physical and mathematical theory.	1. knowing and understanding	IEEE 11073, sensoring, Consumer Healthcare (APPS)
2.1.4.3	Students analyse the interaction between IT and medical diagnostic and therapeutic devices.	2. application and analysing	ISO 80.001

Subtopic 2.1.5 Principles of evidence-based care (principles of clinical research, evidence-based medicine, evidence-based care) [IMIA: 2.6]

No.	Expertise	Level	Content & curricular notes
2.1.5.1	Students acquire knowledge of the most important methods of EBM and Health Technology Assessments including their areas of application.	1. knowing and understanding	IQWiG (German Institute for Quality and Efficiency in Health Care), literature research, literature databases
2.1.5.2	Students are able to critically assess specialist literature from epidemiology as well as HTA and apply the findings to their own work.	2. application and analysing	Analyse HTA reports
2.1.5.3	Students are able to understand, design clinical studies and place them in an overall context.	2. application and analysing	Knowledge of (international) databases, study planning, study design, implementation, study documentation, Good Clinical Practice (CPMP/ICH/135/95)
2.1.5.4	Students can relate “big data“ to evidence-based research and clinical studies.	2. application and analysing	

Topic 2.2 Organisation of the healthcare system

Subtheme 2.2.1 Organisation of healthcare facilities and the healthcare system, interorganisational aspects, integrated care [IMIA: 2.4]

No.	Expertise	Level	Content & curricular notes
2.2.1.1	Students have a basic understanding of the German healthcare system, the political and legal frame conditions and the central processes and players in healthcare organisations.	1. knowing and understanding	Political and self-governing organisations, e.g. in Germany: Federal Ministry of Health (BMG), Federal Joint Committee (G-BA), Institute for Quality and Efficiency in Health Care (IQWiG), Institute for Quality Assurance and Transparency in Health Care (IQTIG), the natioanl Associations of Statutory Health Insurance Physicians and Dentists, German Hospital Associations, associations of physicians, dentists, psychotherapists and pharmacists, non-physician healthcare professions, patient organisations and self-support, etc.

2.2.1.2	Students are familiar with the organisation and organisational structure of outpatient and inpatient healthcare facilities as well as integrated care concepts and the associated cross-institutional service processes.	1. knowing and understanding	Hospital key figures (inpatient beds, inpatient/outpatient case numbers, CMI). Hospital classes (basic care, standard care, ...), hospital owners (private, non-profit, public, state, city, district, professional associations, etc.). Outpatient care (GP, specialist, MVZ, ...). Medical service providers (physiotherapists, ...). Acute and rehabilitation clinics.
2.2.1.3	Students can compare the healthcare systems of selected countries.	1. knowing and understanding	

Subtopic 2.2.2 Political and regulatory framework conditions for information processing in the healthcare sector [IMIA: 2.5]

No.	Expertise	Level	Content & curricular notes
2.2.2.1	Students will be able to name and apply the key principles and legal regulations of data protection and IT security. They know the main institutions and organisations involved in data protection and IT security.	2. application and analysing	In particular GDPR (General Data Protection Regulation of the European Union), IT Security Act, etc.; data protection officers/authorities of the federal and state governments, BSI, etc.
2.2.2.2	Students know the regulatory requirements for the development of medical software and can apply them.	2. application and analysing	Medical Device Regulation, Medical Devices Act (MPG), regulations, IEC 62304, safety classification and interaction with risk management in accordance with ISO 14971, usability requirements, etc.
2.2.2.3	Students know the legal basis of medical documentation.	1. knowing and understanding	Medical documentation obligation in accordance with the Professional Code of Conduct for Doctors (Section 11 (1) MBO), relevant sections of the German Criminal Code (StGB) and Civil Code (BGB), Patient Rights Act, statutory regulations on archiving medical records (e.g. X-ray Ordinance), regulations on digital signatures (eIDAS Regulation (EU), Trust Services Act) and preservation of evidence (BSI TR-03125 - BSI), etc.

2.2.2.4	Students know the national and international regulatory requirements and (data) standards for medical research and are able to apply them.	2. application and analysing	Phases of clinical drug development with their primary objectives including current national and international laws and regulations and ethical standards to be considered in drug development nationally and globally. Good Clinical Practice (GCP) in the planning, conduct and evaluation of a clinical trial. Data standards such as CDISC etc.
2.2.2.5	Students know the regulatory framework for telemedical care.	1. knowing and understanding	MBO (remote treatment), Digital Care Act (DVG), Appointment Service and Care Act (TSVG), etc.

Subtopic 2.2.3 Healthcare management, health economics, quality and resource management in healthcare, patient safety initiatives, public health services, impact assessment [IMIA: 2.7]

No.	Expertise	Level	Content & curricular notes
2.2.3.1	Students have an overview of the remuneration structures in the German healthcare system and are familiar with the different remuneration systems in the outpatient and inpatient sectors. They understand the associated incentive structures and their effects.	1. knowing and understanding	Billing of outpatient services (GOÄ, EBM), inpatient services (DRG system) etc.
2.2.3.2	Students have a basic understanding of the concepts and regulatory framework of quality assurance in medical care. They can develop documentation and evaluation systems focussed on quality assurance.	2. application and analysing	Basic terms and contexts: quality, quality assurance, quality management; patient orientation and patient satisfaction as objectives of quality management; assessment of quality in healthcare and significance of quality indicators; methods of quality assurance, e.g. statutory quality assurance, quality assurance through routine data, external quality comparisons, risk adjustment for quality comparisons, benchmarking, peer review, minimum quantities; clinical risk management; introduction and further development of quality management systems;

			Public and private reporting; pay for performance; international comparisons; evidence-based medicine.
2.2.3.3	Students know the basic principles of the management of material and human resources with regard to the special requirements of medical documentation and billing in this area.	1. knowing and understanding	Fundamentals and interrelationships of purchasing and warehouse management, merchandise management systems, logistics, personnel planning. Medical documentation requirements such as batch documentation obligation, implant register, implant passport, material-based coding and liquidation.
2.2.3.4	Students are familiar with key concepts, initiatives and legal requirements for patient safety.	1. knowing and understanding	Quality and safety requirements, e.g. in the German Drug and Medical Devices Act, Infection Protection Act; quality assurance obligations (external quality assurance and internal quality management), e.g. in SGB V, Patient Rights Act, Hospital Structure Act, drug therapy safety, surgical checklists, etc.
2.2.3.5	Students can explain the field of public health and its sub-areas.	1. knowing and understanding	Subfields: Combating infectious diseases, social medicine, health protection, health statistics and epidemiology, prevention and health promotion, health care, public mental health, health systems research

Chapter 3: Competences in computer science, mathematics and biometrics

Topic 3.1 Informatics and computer science

Subtopic 3.1.1 Basic concepts of computer science such as data, information, knowledge, hardware, software, computer, network, information systems [IMIA: 3.1]

No.	Expertise	Level	Content & curricular notes
3.1.1.1	Students know basic computer science terms such as data, information, knowledge, hardware, software, computer, network, information systems and can differentiate between them.	1. knowing and understanding	
3.1.1.2	Students are familiar with the subdisciplines of computer science and their basic insights and methods.	1. knowing and understanding	
3.1.1.3	Students use the basic terms of computer science correctly in discussions and in written assignments.	2. application and analysing	
3.1.1.4	Students can assign new technical developments and trends in computer science to the subdisciplines of computer science.	2. application and analysing	

Subtopic 3.1.2 Ability to use computers: Word processing and spreadsheets, simple database management systems [IMIA: 3.2]

No.	Expertise	Level	Content & curricular notes
3.1.2.1	Students know the basic functionalities of a typical Office suite and are able to judge which Office tools can be used for which type of problem.	1. knowing and understanding	
3.1.2.2	Students can evaluate and visualise data using a spreadsheet.	2. application and analysing	
3.1.2.3	Students know the possibilities and limitations of simple database management systems and can use such systems to solve suitable problems.	2. application and analysing	

3.1.2.4	Students are able to use the documentation of Office suites to solve problems.	2. application and analysing	e.g. look up commands for macro programming

Subtopic 3.1.3 Ability to communicate electronically, including electronic data exchange with other healthcare providers, use of internet/intranet [IMIA: 3.3].

No.	Expertise	Level	Content & curricular notes
3.1.3.1	Students know the differences between the internet and intranet and know when intranet applications are preferable to internet or cloud solutions.	1. knowing and understanding	
3.1.3.2	Students know the essential legal requirements regarding data protection and data security and are able to take these adequately into account when exchanging data electronically.	2. application and analysing	
3.1.3.3	Students know the relevant standards for data exchange in the healthcare sector, such as HL7 FHIR, and can select and use these for data exchange.	2. application and analysing	
3.1.3.4	Students know and understand the basics of XML, DTD, XML schema, XSLT and tools for editing XML files, such as XML parsers.	1. knowing and understanding	
3.1.3.5	Students are able to define their own XML languages and use them appropriately for the exchange of data.	2. application and analysing	

Subtopic 3.1.4 Methods of practical computer science, in particular programming languages, software engineering, web technologies, algorithms, data structures, database management systems, tools for information and system modelling, theory and practice of information systems, knowledge processing, term/concept representation and elicitation, software architectures [IMIA: 3.4].

No.	Expertise	Level	Content & curricular notes
3.1.4.1	Students know basic data structures and associated algorithms.	1. knowing and understanding	

3.1.4.2	Students are able to use the Unified Modelling Language (UML) in particular to describe software systems.	2. application and analysing	Class diagrams, sequence diagrams, activity diagrams and use case diagrams are particularly relevant
3.1.4.3	Students are able to create, test and document object-oriented software using tools such as development environments, systems for distributed version control, tools for test automation, etc.	2. application and analysing	The teaching of development environments should include distributed development, in particular with systems for distributed version control (e.g. Git).
3.1.4.4	Students are able to create simple interactive web applications using HTML, CSS and a scripting language such as JavaScript.	2. application and analysing	
3.1.4.5	Students can use basic knowledge of the principles and methods of database, information and knowledge-based systems (based on structured and semi-structured data) to solve problems.	2. application and analysing	Students must be able to programme SQL-92 queries

Subtopic 3.1.5 Methods of theoretical computer science, e.g. formal languages, automata theory, decidability and computability, complexity theory, modelling, simulation, encryption/ data security [IMIA: 3.5].

No.	Expertise	Level	Content & curricular notes
3.1.5.1	Students know the basics of computability theory, complexity theory, automata theory and the theory of formal languages.	1. knowing and understanding	
3.1.5.2	Students can distinguish between computable and non-computable problems and are able to estimate the effort required to solve problems.	2. application and analysing	
3.1.5.3	Students are able to protect stored data, electronic communication and electronic data exchange with other healthcare providers from unauthorised access in accordance with the law, e.g. by selecting and using suitable encryption procedures and organisational measures.	2. application and analysing	

3.1.5.4	Students can identify and create context from a wide variety of data sources and are able to translate data relationships into calculable model structures and to visualise and explain them. Existing boundary conditions can be named and their relationship to the model structures described.	3. evaluating and synthesising	
3.1.5.5	Students master common simulation techniques and are able to harmonise available data, questions and simulation methods and create executable models that enable reproducible answers of the models to previously defined questions.	3. evaluating and synthesising	

Subtopic 3.1.6 Methods of technical computer sciences, e.g. operating systems, compiler construction, computer architectures, distributed systems, embedded systems, network architectures and topologies, telecommunications, wireless technologies, virtual reality, multimedia [IMIA 3.6].

No.	Expertise	Level	Content & curricular notes
3.1.6.1	Students know the basic structure, functionality and functional processes of software programs on von Neumann processor architectures and are familiar with optimisation options for memory accesses and the interrupt concept.	1. knowing and understanding	
3.1.6.2	Students know the basics of operating systems, both for desktop and mobile processors.	1. knowing and understanding	
3.1.6.3	Students are familiar with relevant network architectures and topologies, can use these in projects and understand the basic principles of network protocols.	2. application and analysing	
3.1.6.4	Students are familiar with the relevant wireless technologies and are able to select the most suitable technology for their use case.	2. application and analysing	

3.1.6.5	Students are able to select and use suitable file formats for the transmission and storage of multimedia data (image, sound, video).	2. application and analysing	Consider the special requirements of medical diagnostics
3.1.6.6	Students are familiar with current developments and concepts in the field of computer technology, such as requirements for mobile devices in terms of energy efficiency and sensor data processing, augmented, mixed and virtual reality, and can assess the extent to which these can be used to solve problems in the healthcare sector.	3. evaluating and synthesising	

Subtopic 3.1.7 Methods of coupling and integrating information system components in distributed systems [i.A.a. IMIA: 3.7].

No.	Expertise	Level	Content & curricular notes
3.1.7.1	Students know the basic problems for interoperability of information systems.	1. knowing and understanding	Communication between humans and systems, syntactic and semantic aspects, schema and semantic mismatches between systems, role of terminology servers
3.1.7.2	Students know the different technologies for system coupling/interoperability and can apply them depending on their previous knowledge of computer science.	2. application and analysing	Overview of data synchronisation mechanisms, data exchange via email, via RFC/RPC, via web services, brief introduction to SOAP and REST.
3.1.7.3	Students can derive web service specifications from given information models.	3. evaluating and synthesising	Step-by-step procedure for the design of web service interfaces, conversion of class models into hierarchical XML structures or JSON, service customisation based on use cases or interaction scenarios, creation of service matrix, definition of WSDL files.

Subtopic 3.1.8 Dealing with the life cycle of information systems (analysis, requirements specification, implementation or selection of information systems, risk management, training) [IMIA: 3.8].

No.	Expertise	Level	Content & curricular notes
3.1.8.1	Students know the phases of system development from analysis to operation to the end of live as well as various process models.	1. knowing and understanding	Principle software-development phases: Analysis, design, implementation, test, acceptance, introduction, operation / different approaches: linear - spiral model - agile methods
3.1.8.2	Students know different methods of requirements analysis and can apply them.	2. application and analysing	Analysis through evaluation of documents and legacy systems, observation, interviews, workshops / quality criteria for analyses, concepts of requirements engineering
3.1.8.3	Students are familiar with various methods of requirements specification and can apply these to document requirements in a structured manner.	2. application and analysing	Statement collections, use cases, interaction diagrams, processing flowcharts, mockups, information models / UML notation for this purpose
3.1.8.4	Students know the process and aspects of selecting IT solutions and are able to carry one out.	2. application and analysing	Market exploration procedure, tendering process, framework conditions for public clients (VOL, EVB-IT), hierarchical catalogue of features and functionalities, non-functional criteria, aspects of economic efficiency and sustainability of investments, return on investment, utility value analysis for bid evaluation, presentations, provider presentation and discussion, contract aspects and negotiations
3.1.8.5	Students know the procedure for introducing systems and critical success factors for successful implementation.	2. application and analysing	Phases of system implementation, methods and tools for user education, role of first and second level support, error management, data protection/backup strategies, data migration from an old to a new solution

Subtopic 3.1.9 Methods of project management and change management (in particular project planning, resource management, team management, conflict management, cooperation and motivation, theories and strategies for change processes) [IMIA: 3.9].

No.	Expertise	Level	Content & curricular notes
3.1.9.1	Students know the concept of a project and how to define a project, students know different types of projects and accordingly procedures and organisational methods and can name relevant standards.	1. knowing and understanding	Definition of a project, project phases and milestones, specification of work packages, structural and procedural organisation in projects, organisational forms such as line or matrix organisation, roles and role-specific tasks in projects; PRINCE, PM Book, Scrum
3.1.9.2	Students know methods and tools for project planning and can apply them.	2. application and analysing	Definition of Ressources, methods of cost estimation, creation and structure of resource and time planning, GANTT diagram, identification of the critical path, tools for project planning
3.1.9.3	Students can define, set up and maintain project documentation.	2. application and analysing	Document templates for project documents, naming conventions, filing structures, indexing, project documentation using WIKI and DMS/CMS, collaborative creation of project documents, documentation of the completion status and project progress
3.1.9.4	Students know methods and tools for collaboration in projects and team management.	2. application and analysing	Structure and contents of a project manual, moderation of groups/moderation techniques, preparation and realisation of project meetings, definition of reporting and communication structures/paths, team cooperation, conflict management strategies, automation
3.1.9.5	Students know methods and tools for quality and risk management in projects.	2. application and analysing	Identification of risks/risk analysis, definition and monitoring of quality indicators, definition and implementation of escalation chains, project monitoring and early warning systems

Subtopic 3.1.10. Basic concepts and applications of ubiquitous computing (e.g. pervasive computing, sensor-based systems and technologies integrated into the healthcare environment, health-supporting technologies, ubiquitous health)

No.	Expertise	Level	Content & curricular notes
3.1.10.1	Students are familiar with the characteristics, methods, algorithms and technologies of current ubiquitous systems.	1. knowing and understanding	Definition and delimitation of the terms of the subject area, architecture concepts, sensor technology, mobile devices, mobile communication, interfaces.
3.1.10.2	Students are familiar with typical fields of application and scenarios for ubiquitous systems in medicine as well as existing regulatory requirements.	1. knowing and understanding	Discussion of typical fields of application for ubiquitous systems (ambient assisted living, ambient health, smart home, etc.) using the example of specific projects and/or products. Clarification of regulatory issues relating to IT security and data protection.
3.1.10.3	Students are able to develop ubiquitous and context-sensitive systems and applications in the context of medicine.	2. application and analysing	Development of smaller applications using ubiquitous technologies (sensors, middleware, wireless communication, etc.)
3.1.10.4	Students are able to assess the opportunities and risks of using ubiquitous systems and to evaluate their application benefits.	3. evaluating and synthesising	Methodological knowledge for the criteria-based evaluation of ubiquitous systems.

Subtopic 3.1.11. Usability engineering, human-computer interaction, usability evaluation, cognitive aspects of information processing [IMIA: 3.14]

No.	Expertise	Level	Content & curricular notes
3.1.11.1	Students know the basics of and the framework for usability engineering and can plan usability projects.	2. application and analysing	Usability as a concept, usability of application software/criteria, EN ISO 9241 and its parts
3.1.11.2	Students know the basic cognitive principles and their consequences for user interfaces.	1. knowing and understanding	Perception, attention, memory models, visualisation principles
3.1.11.3	Students can test the usability of systems and application settings.	2. application and analysing	Usability test and evaluation methods, analysis of usage observations/usage statistics, etc.
3.1.11.4	Students can analyse and specify user-related requirements (user research).	2. application and analysing	User groups and profiles, specification of usage context, methods of usage analysis, context analysis

3.1.11.5	Students can implement user requirements in prototypes.	3. evaluating and synthesising	Design principles according to ISO 9241-110, creation of mockups for different target environments (classic application, web application, app)

Topic 3.2 Mathematics, biometrics and decision support

Subtopic 3.2.1 Mathematics: algebra, analysis, logic, discrete structures, numerical mathematics, probability theory and statistics, cryptography [IMIA: 3.10]

No.	Expertise	Level	Content & curricular notes
3.2.1.1	Students master the basics of set theory and logic and can apply these to practical problems.	2. application and analysing	Set theory and propositional logic, functions, relations, equivalence relations, proof methods
3.2.1.2	Students master the basics of analysis and can apply them to practical problems.	2. application and analysing	Sets, mappings, relations, complex numbers, convergence of sequences and series, differential and integral calculus with one variable, ordinary differential equations
3.2.1.3	Students master advanced methods of analysis and can apply them to practical problems.	2. application and analysing	2nd order differential equations with constant coefficients, Fourier series, Fourier transform and differential and integral calculus in several variables
3.2.1.4	Students master the basics of linear algebra and can apply them to practical problems.	2. application and analysing	Vector spaces, fields, systems of linear equations, linear and affine mappings, base transformation, homogeneous coordinates, scalar product, eigenvalue problems, quadratic forms
3.2.1.5	Students master the basics of stochastics and can apply them to practical problems.	2. application and analysing	Discrete probability space, Kolmogorov's axioms, combinatorics, conditional probability, stochastic independence, random variables, expected values, higher moments, correlations, Chebyshev's inequality, weak and strong law of large numbers, De Moivre's and Laplace's theorem, introduction to hypothesis testing and estimation theory
3.2.1.6	Students know the basics of statistics and can apply them using statistical software.	2. application and analysing	Task and significance of descriptive/analytical statistics; basic concepts: population, types of survey, sample, characteristics,

			scaling, frequency distributions, class formation; statistical parameters (location and scattering measures) and graphical representation of data; statistical distributions (binomial distribution, normal distribution, etc.); basic principle of a statistical test; application of statistical software (data preparation, data import, evaluation and output)
3.2.1.7	Students master advanced statistical methods and can apply them using statistical software.	2. application and analysing	Methods of inferential statistics for one or two samples, methods for estimating the functional relationship between two characteristics and methods for estimating the required sample size; multi-factorial methods
3.2.1.8	Students know the basics of numerical analysis and can apply them.	2. application and analysing	Error analysis, linear systems of equations and mean-square problems, polynomials, polynomial interpolation, quadrature, non-linear equations
3.2.1.9	Students know the basics of discrete mathematics and can apply them.	2. application and analysing	Fundamentals of elementary number theory (Euclidean algorithm, modulo calculus, Euler's theorem), algebraic structures (groups, rings, solids), combinatorics and graph theory.
3.2.1.10	Students master the basics of cryptography including symmetric and asymmetric cryptographic methods commonly used in practice and can apply these methods.	2. application and analysing	PKI, cryptographic procedures and their relation to the basic problems of IT security (confidentiality, integrity, authentication, non-repudiation), Triple DES, RSA algorithm, Diffie-Hellman key exchange protocol, etc.

Subtopic 3.2.2 Biometrics, epidemiology and research methods in medicine and health care, including study design [IMIA: 3.11].

No.	Expertise	Level	Content & curricular notes
3.2.2.1	Students know the basics of scientific practice in medicine. They know the types of medical studies, principles and basics of controlled randomised studies and epidemiological surveys and can	2. application and analysing	Basic principles of clinical studies, study designs, study types & false conclusions; epidemiological methods / measures in epidemiology: prevalence and incidence, mortality and lethality,

	evaluate them. They are able to appropriately recognise and apply the aspects of planning medical studies.		point versus period prevalence, incidence rate and cumulative incidence; direct and indirect age standardisation; Good Epidemiological Practice (GEP) guidelines, epidemiology as a science and prevention as its practical goal; evaluation of information, evidence-based medicine;
3.2.2.2	Students can apply the most important statistical evaluation procedures for biometrics and epidemiology and correctly interpret the results of inferential statistical procedures.	2. application and analysing	Univariate and bivariate descriptive measures, correlation and regression in clinical research questions, descriptive measures in contingency tables, diagnostic studies and assessment of diagnostic tests, application and interpretation of statistical tests and confidence intervals in clinical studies, case number planning, survival time analysis, interpretation of trends and mortality measures

Subtopic 3.2.3 Methods of decision support and their application to patient care; collection, representation and processing of medical knowledge; construction and use of clinical pathways and guidelines [IMIA: 3.12].

No.	Expertise	Level	Content & curricular notes
3.2.3.1	Students will be able to explain process models and data collection tools for medical knowledge acquisition and apply them in training scenarios.	2. application and analysing	Modelling-view metaphor; protocol analysis, conducting and analysing semi-structured interviews; concept laddering and sorting; ontology-based acquisition approaches
3.2.3.2	Students can use standardised representation formats for medical knowledge to build knowledge bases.	2. application and analysing	Clinical Quality Language; Arden syntax (medical logic modules, time operators, fuzzification); description logics and Web Ontology Language (OWL); top-level ontologies
3.2.3.3	Students are able to operationalise evidence-based guidelines and clinical treatment pathways on the basis of standard formats in a computer executable form.	2. application and analysing	Definitions of guidelines vs. treatment pathway; use of the AWMF portal; AWMF guideline regulations and the meaning of AWMF development stages; use of workflow patterns in guideline

			operationalisation and for comparing different guideline representation formats; Business Process Model and Notation (BPMN)
3.2.3.4	Students will be able to apply established machine learning (ML) methods to implement decision-support systems and explain the respective strengths and weaknesses of ML methods and classical knowledge acquisition in a medical context.	2. application and analysing	Supervised/unsupervised learning; multilinear and logistic regression; support vector machines; ensemble methods (especially random forests); multilayer perceptrons and overview of more complex network topologies; cross-over validation
3.2.3.5	Students can name the socio-technical effects of the introduction of clinical decision support systems in routine practice, explain methods for the measurement of these effects and relevant results, and take these effects into account during implementation.	3. evaluating and synthesising	Known success factors for the introduction and routine use of clinical decision support systems Clinical decision support systems; overalerting; alert fatigue; usability aspects and usability measurement; primary studies (e.g. intervention studies), systematic reviews and meta-analyses on clinical outcomes of system implementation; challenges of multiprofessional communication

Chapter 4 Personal competences

Topic 4.1 Self-competence

Subtopic 4.1.1 Self-competence

No.	Expertise	Level	Content & curricular notes
4.1.1.1	Students can structure a project in terms of time, set and adhere to sensible short and long-term deadlines and deal with delays.	2. application and analysing	Accompany and support time management, e.g. for student projects or theses.
4.1.1.2	Students can motivate themselves to learn and develop personally, persevere with a subject, deal with failure and ensure a healthy learning and working environment.	2. application and analysing	Provide regular feedback, invite reflection on learning progress
4.1.1.3	Students can recognise and critically deal with role and gender stereotypes and know the importance of gender-sensitive language.	2. application and analysing	Have students work on case studies, recognise stereotypes, discuss studies on gender-equitable language in order to discuss the importance of breaking through predefined stereotypes (e.g. “scientists are always male“)
4.1.1.4	Students know their own abilities, characteristics and attitudes and can critically reflect on their own behaviour in social situations.	3. evaluating and synthesising	Enable mutual peer feedback, enable learning diaries, allow group work to be reflected on

Topic 4.2 Methodological competence

Subtopic 4.2.1 Methodological competence

No.	Expertise	Level	Content & curricular notes
4.2.1.1	Students understand that scientific texts symbolise interaction in the knowledge community and know the basic structure of a scientific text.	1. knowing and understanding	Have simple scientific texts and presentations written and give feedback
4.2.1.2	Students can use presentation software appropriately, can structure and give a presentation to suit the target group and can give a free presentation.	2. application and analysing	Have different types of presentations given and provide feedback.
4.2.1.3	Students can understand English specialised texts and presentations, can write an English specialised text and give an English presentation.	2. application and analysing	Have English texts read and presented

4.2.1.4	Students can use theoretical facts to solve practical problems and can reflect on a practical situation against the background of theories.	2. application and analysing	Have practical examples and case studies discussed, discuss experience reports from graduates
4.2.1.5	Students can research specialised literature in a targeted manner, are familiar with relevant specialist databases and can use them, can develop search strategies, can critically evaluate specialised literature in terms of reliability and relevance and can use the information they find in a targeted manner.	2. application and analysing	Have a literature review written
4.2.1.6	Students can recognise their own project as a project and systematically plan and implement it accordingly.	2. application and analysing	Have group work and final theses planned as projects. Offer opportunities for self-reflection on the management of own projects.
4.2.1.7	Students can critically reflect on their own professional self-image, can reflect on their learning experiences and can critically reflect on their own behaviour in a situation.	3. evaluating and synthesising	Create reflections on topics or practical experiences, facilitate discussions with experts
4.2.1.8	Students can identify and analyse technical problems, can develop suitable methods and approaches to solve the problem and can weigh up and select alternative solutions, also with regard to their risks.	3. evaluating and synthesising	Discuss and reflect on practical examples and case studies.

Topic 4.3 Social competence

Subtopic 4.3.1 Social competence

No.	Expertise	Level	Content & curricular notes
4.3.1.1	Students can work together with other people in a goal-oriented and appreciative manner to fulfil a task, can define and adhere to team rules, can name the roles in a team and are prepared to take on a role, can recognise problems in a team and address them appropriately, can recognise and use different perspectives in	2. application and analysing	Facilitate group work, enable reflection on team processes, offer coaching

	interprofessional teams as a resource, know the key phases of team building and can describe which phase a team is in.		
4.3.1.2	Students know the usual rules of dialogue in professional communication, can clearly articulate and defend their own points of view, can convince decision-makers of the need for action, can present alternatives with their strengths and weaknesses and make a convincing proposal for action and can actively listen to an interlocutor and accept other points of view and admit their own mistakes.	2. application and analysing	Facilitate group discussions and have these observed and reflected upon; oral examination discussions; role plays.
4.3.1.3	Students are prepared to take responsibility for leading a group to achieve a goal, can motivate a team towards a common goal, can coordinate and moderate the joint work in a team, know personality styles and can take these into account when assigning roles in the team and know methods for avoiding and resolving team conflicts.	2. application and analysing	Allow small groups to take the lead, enable coaching and reflection
4.3.1.4	Students can analyse the causes of conflicts and can propose and implement solutions to conflicts.	2. application and analysing	Work on case studies (e.g. videos) and reflect on them together, reflect on own experiences, role plays to practise solution strategies