04

Subject-Specific-Criteria of the Technical Committee 04 – Informatics/ Computer Science

For the accreditation of Bachelor's and Master's degree programmes in Informatics and Computer Science (adopted: 29 March 2018)

The following specifications complement the "ASIIN General Criteria for the Accreditation of Degree Programmes".

1 Classification

1.1 Function

The Subject-Specific Criteria (SSC) of the Technical Committee for Informatics and Computer Science have the premise that the intended learning outcomes, formulated by and aspired to Higher Education Institutions in their own responsibility, as well as in accordance with their academic profile, form the central yardstick for the curricular evaluation of the study programmes submitted for accreditation.

In addition, the Subject-Specific Criteria of all ASIIN Technical Committees fulfil a number of important functions:

The SSC are the result of a regular assessment carried out by ASIIN Technical Committees, which summarise what is understood as best practice in higher education in a professional community supported equally by academia and professional practice and what is demanded as future-oriented training quality in the labour market. The expectations outlined in the SSC for the achievement of learning outcomes and competency profiles are not static. Rather, they are subject to a constant examination in close co-operation with organisations of the specialized Community, including associations of faculties and university departments, professional associations and federations of the professional practice.

The Technical Committee 04 – Informatics/Computer Science cooperates closely with the "Fakultätentag Informatik", the "Fachbereichstag Informatik", and the "Gesellschaft für Informatik" (see below) and issues its SSC in close coordination with the quality criteria defined in these organisations. Applicant universities are requested, with the help of the SSC, to critically reflect on the interaction of the learning outcomes, curricula and related quality expectations they themselves strive for and to position themselves in the light of their own university objectives.

In their function in the accreditation procedure, the SSC also represent a professionally elaborated basis for discussion for experts, universities and committees of the ASIIN. They thus make an important contribution to the comparability of national and international accreditation procedures, since it should not be left to the opinion of individual experts which technical parameters flow into the discussion and the individual evaluation. At the same time, the SSC name those abilities, skills and competences which may typically be considered "state of the art" in a subject area, but which can always be exceeded or varied depending on the objectives of a higher education institution.

Against this background, the study objectives and competences for Bachelor's and Master's degree programmes in computer science described in Section 2 of this SSC are intended as support for application and assessment in accreditation procedures.

1.2 Scope and consistency with other subject-specific criteria

These SSC update the ASIIN SSC in the version of 9.12.2011. They are consistent to the *Subject-Specific Criteria (SSC) of the European Quality Assurance Network for Informatics Education* (EQANIE) in the version of 24.10.2016 (EQANIE-SSC), an association of European stakeholders for the review and qualitative further development of Computer Science study programmes. In addition, they are based on the *Empfehlungen der Gesellschaft für Informatik e.V. (GI) für Bachelor- und Masterprogramme im Studienfach Informatik an Hochschulen* in the version of 1.07.2017 (GI recommendations). As a socially relevant, non-profit expert forum, the GI represents computer scientists, companies, authorities, associations and scientific institutions in the field of information technology. As the largest IT professional association, the GI represents the interests of information technology in business, science and politics.

Section 2 of this SSC takes up the "educational goals" of the GI recommendations. However, it should be noted that these SSC focus on competence descriptions.

Bachelor’s programmes

The SSC of the ASIIN and the GI recommendations of 1.7.2016 distinguish three types of Bachelor's programmes:

- Type 1: Courses of study in Computer Science: TC 04 solely responsible
- Type 2: Computer science courses with a special application area: TC 04 responsible in consultation with the involved application area
- Type 3: Interdisciplinary degree programmes with a computer science share that is equal to the share of the other disciplines involved.

The present SSC refer primarily to Type 1 and Type 2 Bachelor’s programmes. With regard to the weighting of the targeted computer science competences and the proportions of the corresponding content areas, the table (1) given in the GI recommendations in Section 4.1 „*Typisierung der Studiengänge*“ can be used as a rough guide. It should be noted here that these SSC expressly do not require strict adherence to the credit point areas shown in Table 1 of the GI recommendations or to areas specified as percentages for individual study proportions. The requirement (of these SSC) consists much more in the fact that the different study parts (computer science, mathematical/scientific/technical basics, area of application/subject, interdisciplinary basics and key competences) stand in a coherent relationship with regard to the study goals.

With regard to type 3 Bachelor's programmes (outside the focus of these SSC), the primary assessment criterion is mentioned: The selected study contents and teaching/learning formats or the competences to be acquired by the students in the course of their studies must form a self-contained unit and be suitably selected in their interaction with the addressed other subject areas.

Master's programmes

According to the current resolution of the "Kultusministerkonferenz" (KMK), a distinction is made between consecutive and non-consecutive Master's programmes. Just as for Bachelor's programmes, the GI recommendations of 1.7.2016 also differentiate between the three types mentioned above for Master's programmes.

These SSC do not apply to non-consecutive Master's programmes.

The GI recommendations also differentiate between deepening and broadening Master's programmes.

These SSC refer primarily to consecutive, in-depth Type 1 and Type 2 Master's programmes. With regard to the weighting of the targeted computer science competences and the proportions of the corresponding content areas, the table (2) given in the GI recommendations in Section 4.1 "*Typisierung der Studiengänge*" can be used as a rough guide. It should be noted here that these FEH explicitly do not require strict adherence to the credit point areas listed in Table 2 of the GI recommendations or to areas specified as percentages for individual study proportions. The requirement (of these SSC) consists rather in the fact that the different study portions (information, area of application/subject, interdisciplinary specialisations, interdisciplinary key competences) are in a harmonious relationship with regard to the study objectives.

Also with regard to Type 3 Master programmes (outside the focus of these SSC), it should be mentioned as a primary assessment criterion: The selected study contents and teaching/learning formats or the competences to be acquired by the students in the course of their studies must form a self-contained unit and be suitably selected in their interaction with the other addressed subject areas.

1.3 Collaboration of the Technical Committees

The Technical Committee 04 – Informatics/Computer Science works together with the other technical committees of the ASIIN, especially in order to meet the requirements of interdisciplinary study programs. The universities are requested to give their assessment for the assignment to one or more subject committees in the course of the registration of an accreditation procedure.

In the case of Type 1 and Type 2 study programmes, the Technical Committee 04 – Informatics/Computer Science usually takes the lead in the accreditation procedure and, if necessary, consults experts from other fields. For Type 3 study programmes, the TC 04 is jointly responsible with the participating disciplines for Computer Science or provides expert reviewers accordingly.

2 Educational Objectives – Competencies

Graduates of Bachelor's and Master's degree programmes at universities should be qualified for successful work throughout their professional lives or for further scientific studies in this field.

In the sense of "outcome orientation", this section first examines the requirements for computer scientists from the perspective of working life. Core competences are derived from this, which refer to different content areas, which are also mentioned, but only in brief and with an exemplary character. **The focus of these SSC is clearly on the description of the core competences that are to be taught in every computer science course (Type 1 or Type 2).**

In general, computer science study is scientifically founded and conveys broad and in selected subareas deepened technical knowledge, in order to develop and maintain soft- and hardware systems analytically, creatively and constructively. Furthermore, not only contemporary contents are taught, but also theoretically underpinned concepts and methods that survive current trends and enable lifelong learning.

Different degree programmes have different objectives and differ in breadth and depth. The basic skills described below must be implemented in computer science studies. The development of the individual competences depends on the individual study programme - various aspects, such as tool approach, procedures, technological details or certain personal competences, are only deepened in professional life or within the framework of further studies. Against this background, the competences in this section are described in general terms for graduates of computer science degree programmes.

2.1 Requirements on Bachelor’s Degree Programmes

This section describes the core competencies that should be taught in every computer science bachelor's programme. This requirement applies to Type 1 and Type 2 programmes.

The Bachelor's programme conveys a broad spectrum of specialist knowledge and the fundamentals necessary for entry into professional practice. Graduates must be able to implement the scientific findings and problem-solving concepts in application areas.

They should be able to contribute to the quality solution of problems in almost all fields of application of computer science in cooperation with experts from these fields. They work on the solution of complex problems and can further develop concepts, methods, procedures, techniques and tools of computer science.

Computer scientists with a Bachelor's degree have acquired a basic understanding of the central concepts and methods of their discipline, know important current developments in their subject and can place their knowledge and skills in a larger context.

Based on their Bachelor's degree, graduates can adapt to the dynamically changing requirements resulting from technological developments and changing application requirements.

Training in a Bachelor's programme is intended to enable students to continue their studies successfully in a Master's programme at national or international level. It must also impart the ability to open up new areas and to pursue continuing education independently.

2.1.1 Formal, Algorithmic and Mathematical Competencies

Computer scientists must describe problems and requirements precisely in order to convert them into suitable data structures and efficient algorithms.

For the modelling of problems and facts, abstract logical and algebraic calculations, graph-theoretical notations, formal languages and automata as well as special calculations are used. To solve a problem, procedures are used to identify the algorithmic core of the problem. Based on these procedures, algorithms are designed, verified and evaluated with regard to their resource requirements. The calculations contained in the algorithms are thus used for appropriate technical communication and evaluation of problem solutions within the framework of cooperative working relationships. For special areas of information processing, such as signal and image processing, cryptography or pattern recognition, advanced knowledge of analysis, algebra, combinatorics and statistics is required.

Exemplary content areas for formal, algorithmic and mathematical competences of Bachelor's programme are:

- *Discrete Structures, Logic and Algebra*
- *Analysis and Numerics*
- *Probability Theory and Statistics*
- *Formal Languages and Abstract Machines*
- *Modelling*
- *Algorithms and Data Structures*

2.1.2 Analysis, Design, Implementation and Project Management Competencies

Analysis competence includes above all the will and ability to communicate and cooperate with task setters and future system users and to quickly familiarise oneself with new application contexts. Computer scientists must be able to recognize known problems in the application context and be familiar with the associated solution patterns. They recognize inconsistencies and can deal with unclear requirements. Complex domains can be modelled and large application tests can be broken down into sub-problems using appropriate interfaces.

Design competencies include the ability to design hardware and software systems that fully meet the requirements. Abstraction capability is also indispensable for this, as is solid knowledge of software architecture. Human-technology interfaces can be designed application-oriented and ergonomically. Central to the design is the implementation of non-functional requirements such as security, performance, scalability, maintainability, expandability and reliability.

The ability to professionally create and carefully test larger program systems is a key part of the implementation competence. For this, they should master the common programming paradigms and be familiar with modern software development methods. For the maintenance and extension of software, the ability to familiarize oneself with existing source code and to develop it further is necessary. Knowledge of configuration, change, release, and deployment management is important when dealing with larger systems.

Project management skills are needed to design work processes and, in particular, to organize one's own and other people's work. For this purpose, the ability to work in a team and the constructive examination of concepts and proposed solutions are essential. Computer scientists have learned to develop solutions, even with limited resources, that meet generally accepted quality standards and are accepted by all stakeholders. This requires basic knowledge of estimating and measuring effort and productivity.

Exemplary content areas for analysis, design, implementation and project management competencies of Bachelor's programmes are:

- *Programming Languages and Methodology*
- *Software Engineering*
- *Human-Computer Interaction*
- *Project and Team Competence*

2.1.3 Technological Competencies

Computer scientists must have a broad and very diverse range of specialist skills. This includes knowledge of modern operating systems, computer architecture and computer networks and their application in concrete problems and application contexts. In the field of real-time systems and embedded systems, an understanding of the interaction of a computer with its environment, the use of concurrent systems and system-oriented implementation are of great importance. In the field of databases, not only the theoretical basics but also the process of database design up to the operation of the database-supported application system as well as data analysis and basics of machine learning have to be mastered. Increasingly, a sound knowledge of security measures and mechanisms is required.

Examples of content areas for technological competencies of Bachelor's programmes are:

- *Digital Technology and Computer Organisation*
- *Operating Systems*
- *Computer Networks and Distributed Systems*
- *Databases and Information Systems*
- *IT Security*

2.1.4 Methodological and Transfer Competencies

In addition to the analytical skills required in all university courses of study - such as the competence to acquire knowledge or to work scientifically - computer scientists need further methodological skills in professional practice. For example, they must be able to empirically evaluate IT systems using systematic procedures. The dynamics of the development in the field of computer science require a transfer competence with which they are able to introduce new computer science methods into an often historically grown operational practice. This transfer competence includes the ability to analyse and evaluate an existing operating context and to apply current adequate methods, as well as to evaluate the newly generated operating context.

Exemplary content areas for methodological and transfer competencies of Bachelor's programmes are:

- *Analysis of computer systems in their application context*
- *Implementation and evaluation strategies*
- *Strategies of knowledge acquisition and scientific training*

The methodological and transfer competences described are acquired primarily together with the technical competences in various areas of computer science.

2.1.5 Interdisciplinary Competencies

Graduates must be able to work on tasks in various fields of application under given technical, economic, ecological and social boundary conditions with the means of computer science and to develop appropriate systems. It is important to maintain an open-minded attitude, without which the core competence of information technology cannot fully unfold in practice. Computer scientists require a basic knowledge of business administration, since the planning, development and use of all computer systems take place under economic conditions. They should also have at least basic legal knowledge, as they often have to negotiate legally binding documents such as framework agreements, project-specific contracts, and license or usage agreements. The legal basis of security aspects should also be taken into account, as should questions of copyright and product liability. Computer scientists must be aware of the professional ethical framework and be able to assess the effects of their work on future users and on society in its social, economic, organisational, psychological and legal aspects.

Examples of content areas for interdisciplinary basic competencies of Bachelor's programme are social, professional ethical, economic, ecological and legal aspects of IT systems in an application context.

2.1.6 Social Competencies and Self-Competencies

Computer scientists need communicative skills in order to present their ideas and proposed solutions convincingly in writing or orally, to recognise differing positions and to integrate them into a solution that is appropriate to the subject and the interests at hand. As part of their personal competence, computer scientists should be aware of their professional roles, the associated expectations and any role conflicts in communication situations and be able to contribute to conflict resolution.

Examples of content areas for social and personal competencies of Bachelor's programmes are cooperation management, diversity and conflict management, organisational development.

2.2 Requirements on Master’s Degree Programmes

The in-depth consecutive Master's programme must be based on a first university degree qualifying for a profession and impart deeper competences in the field of computer science. The aim of the corresponding modules must be to enable students to derive and develop scientific methods of computer science for difficult and complex problems, both in practice and in research, and to apply them together with the corresponding findings.

The Master's programme must enable students to take up a scientific occupation with the aim of obtaining a doctorate.

3 Teaching, Learning, and Examination Forms

Courses shall be designed in such a way that lectures are supplemented to an appropriate extent by exercises, seminars, laboratories or internships, projects, etc.

As an indispensable design feature of Bachelor's degree programmes, it is recommended that a project be organised to exemplarily process tasks from the field of software development in a team. The number of students involved in a project should be such that there is sufficient reason to organize the project and to coordinate the interfaces. The concrete project tasks thereby provide an opportunity to impart and practice key qualifications.

Analogous to the Bachelor programmes, it is also recommended for Master programmes to integrate at least one project event for the processing of larger task complexes. When estimating the costs of the project or evaluating it with credit points, it should be taken into account that the project team is given the opportunity to test all phases of a project. In this case, for example, the corresponding course can extend over a longer period of time (about two semesters).

Another necessary characteristic of computer science degree programmes is a sufficient number of seminars (and/or proseminars in Bachelor’s programmes), which also serve to impart or strengthen non-technical competences.

Both Bachelor's and Master's degree programmes are concluded with a final thesis (Bachelor's or Master's thesis), the task and scope of which ensures that students work independently on a scientific question from the field of computer science, using scientific methods and at a level corresponding to the desired degree. The Master's thesis is particularly scientific and, if necessary, research-oriented.

The choice of the type of examination not only has a great influence on the students’ ability of successfully completing a course, but also represents an instrument for guaranteeing the overall qualification envisaged by the course of study. The breadth of the knowledge, skills and competences to be acquired in computer science studies requires a **breadth of assessment forms**. In addition to the traditional examinations, other assessment forms such as project work, oral examinations, seminar papers, presentations and portfolios can also be used for adequate examination. The examination form of a module must be oriented to the acquisition of competence envisaged in the module. The following points should be observed when choosing the type of examination and the examination regulations:

- In addition to factual knowledge, the mastery of IT working methods and procedures and the findings, methods and thought structures on which they are based should also be examined.

- The mastery of subject-specific methods and the procedures based on them must also be checked by oral examinations and other oral examination elements such as presentations or colloquia. These types of examinations are suitable for courses with a small number of participants. If modules serve the acquisition of several competences, a combination of different examination forms may be appropriate.

- In the profile-giving modules of the degree programme, the examinations should prove the student's ability to act in the contexts of these modules. Examiners should not merely rely on knowledge queries, rather they should ensure the use of adequate examination forms.