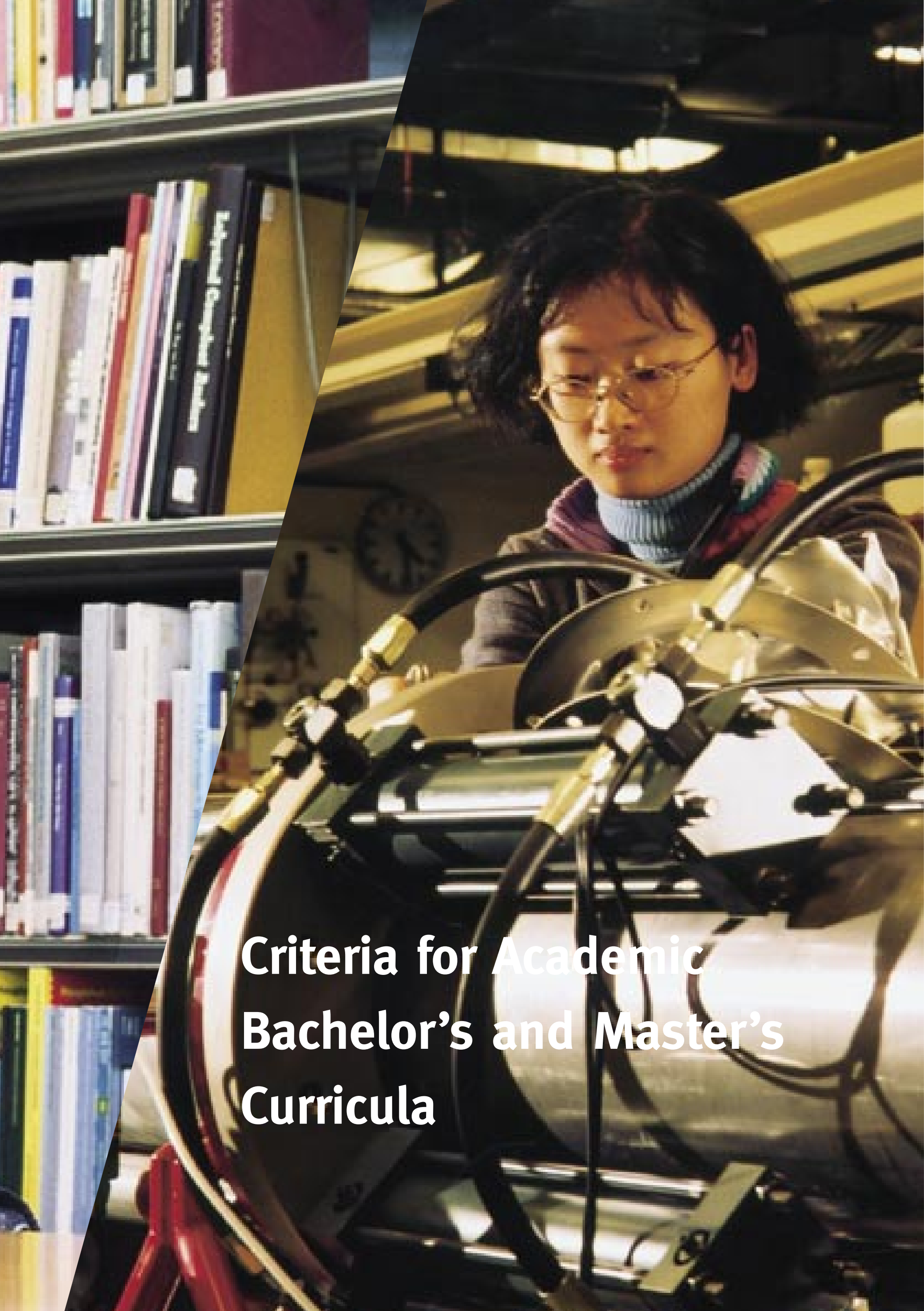
Criteria voor academische bachelor en master curricula = Criteria for academic bachelor's and master's curricula

Meijers, A.W.M.; Borghuis, V.A.J.; Mutsaers, E.J.P.J..; van Overveld, C.W.A.M.; Perrenet, J.C.



Criteria for Academic Bachelor's and Master's Curricula

This booklet is a joint publication of:

Delft University of Technology

technische universiteit eindhoven

University of Twente
The Netherlands

It can be ordered from:

Delft University of Technology
Universiteitsdienst
Mrs P. Spoor
p.n.spoor@tudelft.nl
Tel. +31 (0)15 278 55 57

Eindhoven University of Technology
Secretary Platform
Academic Education TU/e
Mrs M. Rossou - Rompen
M.E.H.A.Rossou@tue.nl
Tel. +31 (0)40 247 34 08

University of Twente
Bureau Communicatie
Mrs S. Kampherbeek
s.h.g.kampherbeek@utwente.nl
Tel. +31 (0)53 489 22 11

Colophon:
Criteria for Academic Bachelor's and Master's Curricula
Authors: A.W.M. Meijers, C.W.A.M. van Overveld, J.C. Perrenet
with the co-operation of V.A.J. Borghuis and E.J.P.J. Mutsaers

Translation: D. Ogretir
Photography: Rob Stork
Design: vanRixtelvanderPut ontwerpers
Production supervision: Communicatiebureau Corine Legdeur
Printing: Drukkerij Lecturis

ISBN: 90-386-2217-1
NUR: 846
Keywords: Higher education

Foreword

This is the second, revised edition of the booklet *Criteria for Academic Bachelor's and Master's Curricula*. It gives a more detailed interpretation of what is meant by academic education at our institutions. The development of a systematic framework for this purpose was originally started at Eindhoven University of Technology. The results of this effort have by now been adopted by Delft University of Technology and the University of Twente.[1]

The changes in the second edition are based mainly on experience gained during a pilot project involving the description and analysis of the academic profiles of two Eindhoven programmes of study. In addition, a number of international publications have been consulted. The most significant changes are the removal of overlaps, the sharpening and clarification of criteria where necessary, and the strengthening of the structure. Moreover, the areas of competence of *doing research* and *designing* are treated more analogously. Finally, the nomenclature of the seven areas of competence has been made consistent.

We trust this booklet will lay a solid foundation for discussions about academic education at our three technical universities, and hope that it will play a useful role in the development, execution, and evaluation of our Bachelor's and Master's curricula, as well as in accounting to external bodies.

January 2005

Drs. P.M.M. Rullmann
Vice-President for Education
Delft University of Technology

Prof.dr. R.A. van Santen
Rector Magnificus
Eindhoven University of Technology

Prof.dr. W.H.M. Zijm
Rector Magnificus
University of Twente

[1] The criteria for academic education have also been adopted by the Radboud University of Nijmegen. A separate edition of this booklet has been published In the context of two collaborative projects between the universities of Eindhoven and Nijmegen.

introduction

It is the mark of an educated mind to be able to entertain a thought without accepting it.
Aristotle (384 – 322 BC)

The question of what it means to have an academic education appears, at first sight, to be a simple one. Someone is academically educated when he or she has successfully completed a university education. This, however, is the very answer which it is no longer possible to give in view of the present system of accreditation of higher education programmes in the Netherlands. For, in this system, the question of whether a programme of study merits the predicate 'academic' no longer depends on the institution in which that programme is embedded, but on the content-related characteristics of that programme. And this means that the institutional answer given above to the question of what it means to be academically educated needs to be replaced by a content-related one.

For the universities, this means that they need to reformulate what they stand for in the field of education. What is the university's educational mission, what is its position in the educational spectrum in the years to come, and what is the relationship between education and scientific research? The answer to this question will vary between the different scientific disciplines and programmes of study. There will, however, also be a shared core: that which university programmes stand for in common. This can be described in terms of academic education.

Moreover, for the universities of technology justice needs to be done to the complex world of the engineering sciences. Here, design and application play an important role in addition to the development of theories. They are not just concerned with the analysis, modelling, explanation or interpretation of phenomena, but also with the synthesis of knowledge for designing and making new technological artefacts and systems in a concrete social context. This is why imagination, creativity, problem solving, and integration of knowledge are important characteristics of an academically educated engineer.

Academic Competences

The starting points for this document were the final report by the Accreditation Committee Higher Education,[1] an unofficial list of qualifications for Bachelor's and Master's degrees of the VSNU (Association of Universities in the Netherlands), and a memorandum on designing at an academic level prepared earlier by the Platform Academic Education of the TU/e. Although it is very important to technological universities, little attention has yet been paid to this last topic in the national debate about academic education. On the basis of the above material and supplementary analyses, a number of areas of competence that characterise a university graduate have been distinguished.

The results were published in the first edition of this booklet, and their usefulness was subsequently tested in an extensive pilot project. Two TU/e programmes were described and analysed in terms of the areas of competence. The contributions of all the compulsory courses to the development of the academic competences were mapped out. This was done on the basis of thorough interviews with the lecturers involved. This project led to a number of adjustments such as the removal of overlaps, the sharpening of formulations and the strengthening of the structure.[2] A number of international publications were also consulted for this revised edition. The academic competences described here can be regarded as the translation into operational terms for universities of the far broader Dublin descriptors which were formulated from 2002 onwards, and which are used by various policy agencies.[3]

1 Final report Accreditation Committee Higher Education Prikkelen, Presteren en Profileren *(Stimulate, Achieve and Profile) (Franssen Committee), publication by the Ministry of Education, Culture and Science, 2001.*

2 The authors would very much like to extend their gratitude to the lecturers of the Industrial Engineering *and* Management Science and Technological Innovation Sciences *programmes for their valuable comments about earlier versions of this publication.*

3 See http://www.jointquality.org/ for the Dublin descriptors. There is also kinship with the competences distinguished in the European Tuning project (Final Report, Phase 1, Bilbao 2003). See http://europa.eu.int/comm/education/policies/educ/tuning/tuning_en.html

On the basis of the aforementioned research, it is possible to distinguish seven areas of competence that characterise a university graduate.
He or she

1. ***is competent in one or more scientific disciplines***
   A university graduate is familiar with existing scientific knowledge, and has the competence to increase and develop this through study.
2. ***is competent in doing research***
   A university graduate has the competence to acquire new scientific knowledge through research. For this purpose, research means: the development of new knowledge and new insights in a purposeful and methodical way.
3. ***is competent in designing***
   As well as carrying out research, many university graduates will also design. Designing is a synthetic activity aimed at the realisation of new or modified artefacts or systems with the intention of creating value in accordance with predefined requirements and desires (e.g. mobility, health).
4. ***has a scientific approach***
   A university graduate has a systematic approach characterised the development and use of theories, models and coherent interpretations, has a critical attitude, and has insight into the nature of science and technology.
5. ***possesses basic intellectual skills***
   A university graduate is competent in reasoning, reflecting, and forming a judgment. These are skills which are learned or sharpened in the context of a discipline, and which are generically applicable from then on.
6. ***is competent in co-operating and communicating***
   A university graduate has the competence of being able to work with and for others. This requires not only adequate interaction, a sense of responsibility, and leadership, but also good communication with colleagues and non-colleagues. He or she is also able to participate in a scientific or public debate.
7. ***takes account of the temporal and the social context***
   Science and technology are not isolated, and always have a temporal and social context. Beliefs and methods have their origins; decisions have social consequences in time. A university graduate is aware of this, and has the competence to integrate these insights into his or her scientific work.

There are relations between the areas of competence mentioned above. They concern (a) the domain of the university graduate – understood here as the fields of study involved (areas of competence 1, 2, and 3), (b) the academic method of thinking and doing (areas of competence 4, 5, and 6), and (c) the context of practicing science (area of competence 7).

The figure below gives a graphical representation of the areas of competence.

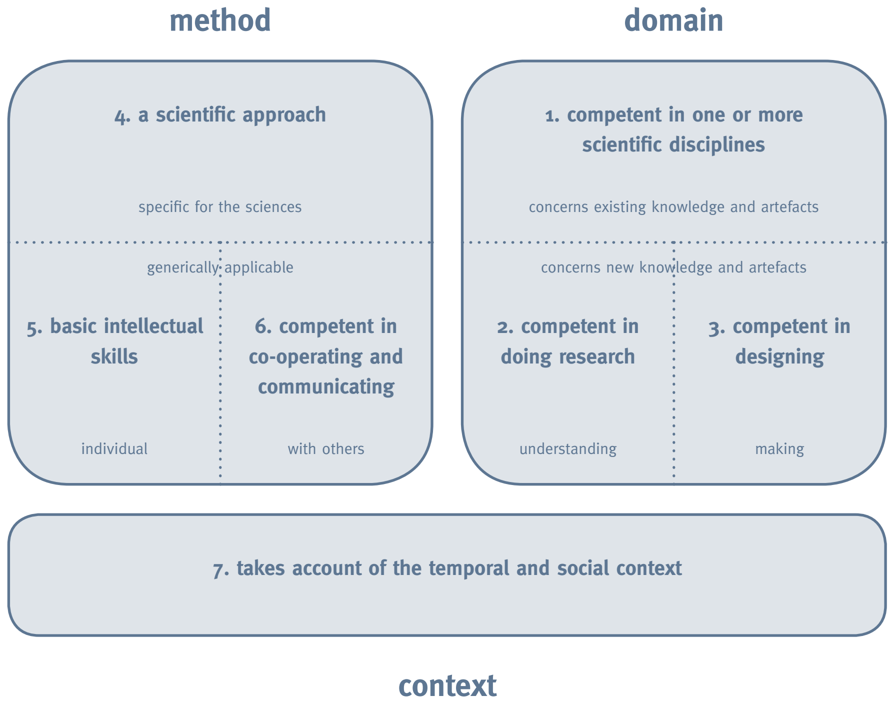


Figure 1: the areas of competence of a university graduate

The seven areas of competence are further developed in this booklet. In doing this, a distinction is made between Bachelor's and Master's competences. The Master's competences should be interpreted as an extension of the Bachelor's competences. As the formulation of competences sometimes places the emphasis where it is not intended, it will always be indicated by means of k, s, and a whether the competence concerned relates mainly to knowledge, skills or an attitude. In the analysis below, skills are almost always combined with knowledge for university graduates, and Master's competences mostly have an attitude aspect. It is not sufficient for a Master to know or to be able to do something – he or she must also have the attitude to use that knowledge or skill in relevant situations.

Dimensions

What is still lacking from the characterisation of the competences is an indication of level. There are usually gradations of competences – from less competent to more competent. With academic competences, such levels will often be expressed in terms of complexity. A university graduate can think and act, research and design, reason and reflect, and so on at a certain level of complexity. Instead of giving levels for all competences, four dimensions which are characteristic of academic thought and action are distinguished below. Scales, along which levels of competences can be specified, can be associated with these dimensions.[4] The dimensions are:

a. analytic

Analysing is the unravelling of phenomena, systems, or problems into sub-phenomena, sub-systems or sub-problems with a certain intention. The greater the number of elements involved, or the less clear it is what the elements of the resulting analysis are, the more complex the analysis.

b. synthetic

Synthesising is the combining of elements into a coherent structure which serves a certain purpose. That result can be an artefact, but also a theory, interpretation or model. The greater the number of elements involved, or the more closely knit the resulting structure, the more complex the synthesis.

4 See Tijn Borghuis, Anthonie Meijers and Kees van Overveld, "Vier Dimensies van Academische Vorming" (Four Dimensions of Academic Education), http://www.tue.nl/academiceducation, for a more elaborate discussion of this.

c. abstract

Abstracting is the bringing to a higher aggregation level of a viewpoint (statement, model, theory) through which it can be made applicable to more cases. The higher the aggregation level, the more abstract the viewpoint.

d. concrete

Concretising is the application of a general viewpoint to a case or situation at hand. The more aspects of a situation are involved, the more concrete the viewpoint.

Explanations and examples of the competences and the dimensions will be given in the form of hyperlinks in the electronic version of this document where necessary (see http://www.tue.nl/academiceducation).

Criteria for Academic Bachelor's and Master's Curricula

The above competences and the associated dimensions can be used in many ways in university education. Firstly, they not only describe the characteristics of a university graduate, but they also provide the basis for the *generic* learning targets of a university curriculum. After all, academic programmes aim at educating people who have developed these competences to a certain level. In addition, they can be used as a conceptual and judgmental framework in the development, description, analysis, and evaluation of programmes. They can also serve as a source of inspiration for the determination of learning targets of individual courses.

A very different type of use is the articulation of the *academic profile* of a programme. The areas of competence will not have the same relevance for all university programmes. The area of competence *designing*, for example, will play a more important role at a technological than at a general university. This means that programmes can define essential aspects as well as minimum levels in terms of academic competences. Such an academic profile can also be visualised. One way of doing this is on the basis of the amount of study time (ects) spent on a particular area of competence. This yields a so-called radar plot (see figure 2).

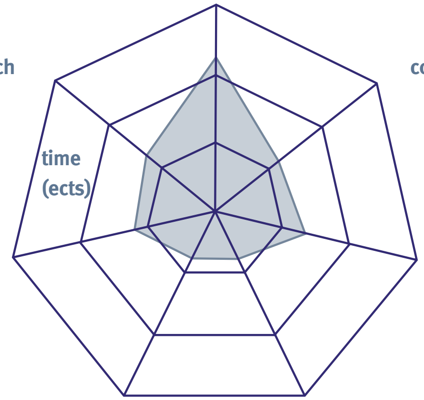


figure 2: example of the academic profile of a study programme

Still another type of use is the testing of students in terms of the academic competences. This can be done in various ways: as an entrance test (Bachelor's or Master's degrees), as an exit test (Bachelor's or Master's degrees) or as a self-test as part of competence-oriented education.

To conclude

Sceptics will believe that it is impossible to analyse the concept of academic education further, and to translate it into operational terms for the purpose of university education. It is too strongly related to erudition which is the result of a lifelong practice of science. The authors of this booklet, however, believe that such a view amounts to throwing in the towel prematurely. First of all, it remains to be seen whether erudite scientists satisfy criteria which are qualitatively different from those applied to graduates, for example. It is quite possible that they merely occupy a different position on the same scale. And, secondly, developments in higher education force universities to be explicit about the final qualifications of their graduates. This calls for clarity with regard to both the concept of academic education and the manner in which it is deployed in the programmes of study.

It is certainly not the purpose of this document to end the debate about academic education. First of all, this would be impossible. And, secondly, it would be undesirable. The debate about academic education is as old as the university itself, and will need to be conducted again in every era. The contribution of this document to this debate is to translate the idea of academic education into operational terms for the Bachelor's and Master's curricula.

1 competent in one or more scientific disciplines

A university graduate is familiar with existing scientific knowledge, and has the competence to increase and develop this through study.

Bachelor	Master
Understands the knowledge base of the relevant fields (theories, methods, techniques). [ks]	Has a thorough mastery of parts of the relevant fields extending to the forefront of knowledge (latest theories, methods, techniques and topical questions). [ks]
Understands the structure of the relevant fields, and the connections between sub-fields. [ks]	Looks actively for structure and connections in the relevant fields. [ksa]
Has knowledge of and some skill in the way in which truth-finding and the development of theories and models take place in the relevant fields. [ks]	Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
Has knowledge of and some skill in the way in which interpretations (texts, data, problems, results) take place in the relevant fields. [ks]	Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
Has knowledge of and some skill in the way in which experiments, gathering of data and simulations take place in the relevant fields. [ks]	Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
Has knowledge of and some skill in the way in which decision-making takes place in the relevant fields. [ks]	Has the skill and the attitude to apply these methods independently in the context of more advanced ideas or applications. [ksa]
Is aware of both the presuppositions of the standard methods and their importance. [ksa]	Is able to reflect on standard methods and their presuppositions; is able to question these; is able to propose adjustments, and to estimate their implications. [ksa]
Is able (with supervision) to spot gaps in his / her own knowledge, and to revise and extend it through study. [ks]	Idem, independently. [ksa]

k=knowledge, s=skill and a=attitude

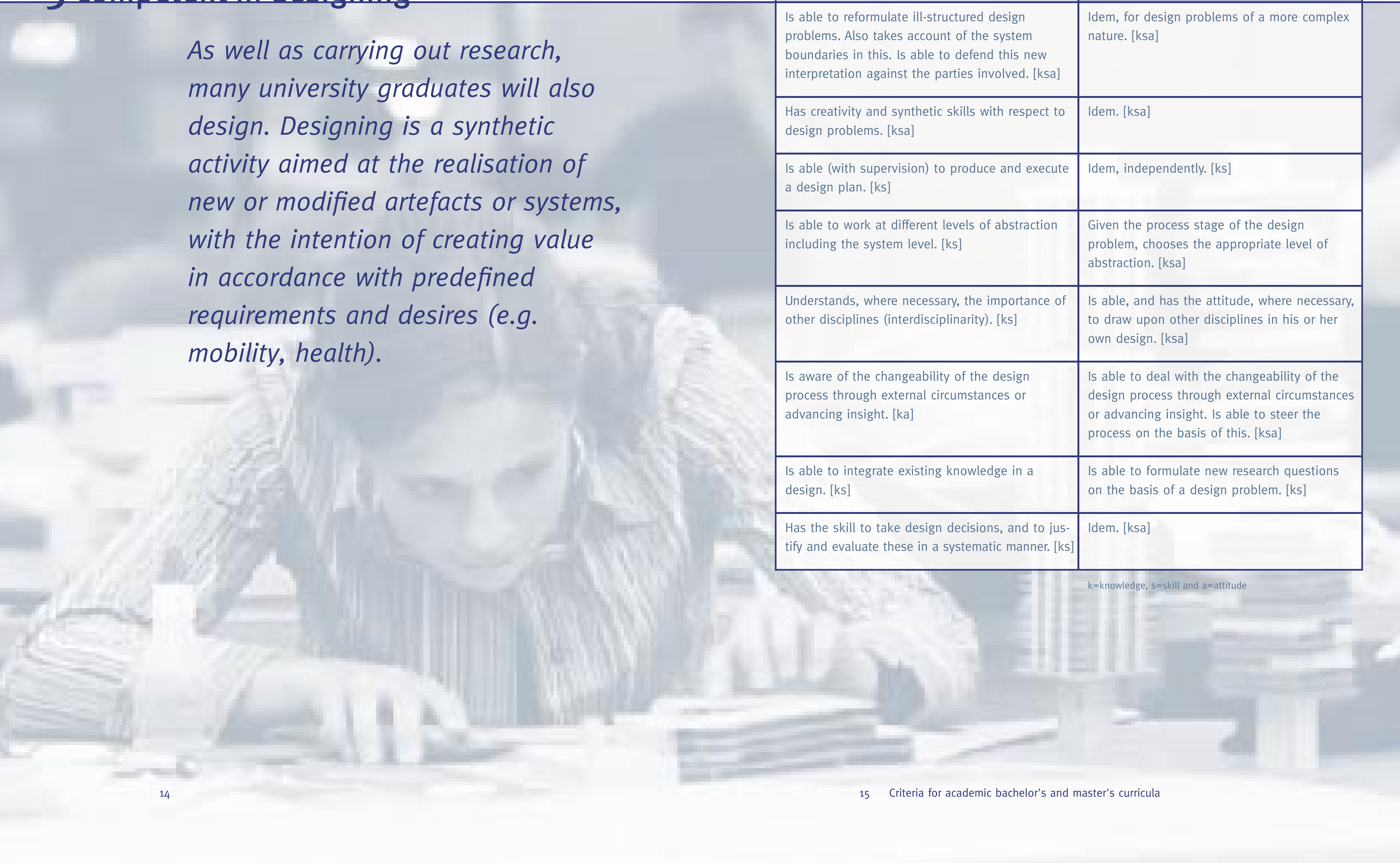
2 competent in doing research

A university graduate has the competence to acquire new scientific knowledge through research. For this purpose, research means: the development of new knowledge and new insights in a purposeful and methodical way.

Bachelor	Master
Is able to reformulate ill-structured research problems. Also takes account of the system boundaries in this. Is able to defend the new interpretation against involved parties. [ksa]	Idem, for problems of a more complex nature. [ksa]
Is observant, and has the creativity and the capacity to discover in apparently trivial matters certain connections and new viewpoints. [ksa]	Idem, and is able to put these viewpoints into practice for new applications. [ksa]
Is able (with supervision) to produce and execute a research plan. [ks]	Idem, independently. [ks]
Is able to work at different levels of abstraction. [ks]	Given the process stage of the research problem, chooses the appropriate level of abstraction. [ksa]
Understands, where necessary, the importance of other disciplines (interdisciplinarity). [ka]	Is able, and has the attitude to, where necessary, draw upon other disciplines in his or her own research. [ksa]
Is aware of the changeability of the research process through external circumstances or advancing insight. [ka]	Is able to deal with the changeability of the research process through external circumstances or advancing insight. Is able to steer the process on the basis of this. [ksa]
Is able to assess research within the discipline on its usefulness. [ks]	Is able to assess research within the discipline on its scientific value. [ksa]
Is able (with supervision) to contribute to the development of scientific knowledge in one or more areas of the disciplines concerned. [ks]	Idem, but independently. [ksa]

k=knowledge, s=skill and a=attitude

3 competent in designing



As well as carrying out research, many university graduates will also design. Designing is a synthetic activity aimed at the realisation of new or modified artefacts or systems, with the intention of creating value in accordance with predefined requirements and desires (e.g. mobility, health).

Bachelor	Master
Is able to reformulate ill-structured design problems. Also takes account of the system boundaries in this. Is able to defend this new interpretation against the parties involved. [ksa]	Idem, for design problems of a more complex nature. [ksa]
Has creativity and synthetic skills with respect to design problems. [ksa]	Idem. [ksa]
Is able (with supervision) to produce and execute a design plan. [ks]	Idem, independently. [ks]
Is able to work at different levels of abstraction including the system level. [ks]	Given the process stage of the design problem, chooses the appropriate level of abstraction. [ksa]
Understands, where necessary, the importance of other disciplines (interdisciplinarity). [ks]	Is able, and has the attitude, where necessary, to draw upon other disciplines in his or her own design. [ksa]
Is aware of the changeability of the design process through external circumstances or advancing insight. [ka]	Is able to deal with the changeability of the design process through external circumstances or advancing insight. Is able to steer the process on the basis of this. [ksa]
Is able to integrate existing knowledge in a design. [ks]	Is able to formulate new research questions on the basis of a design problem. [ks]
Has the skill to take design decisions, and to justify and evaluate these in a systematic manner. [ks]	Idem. [ksa]

k=knowledge, s=skill and a=attitude

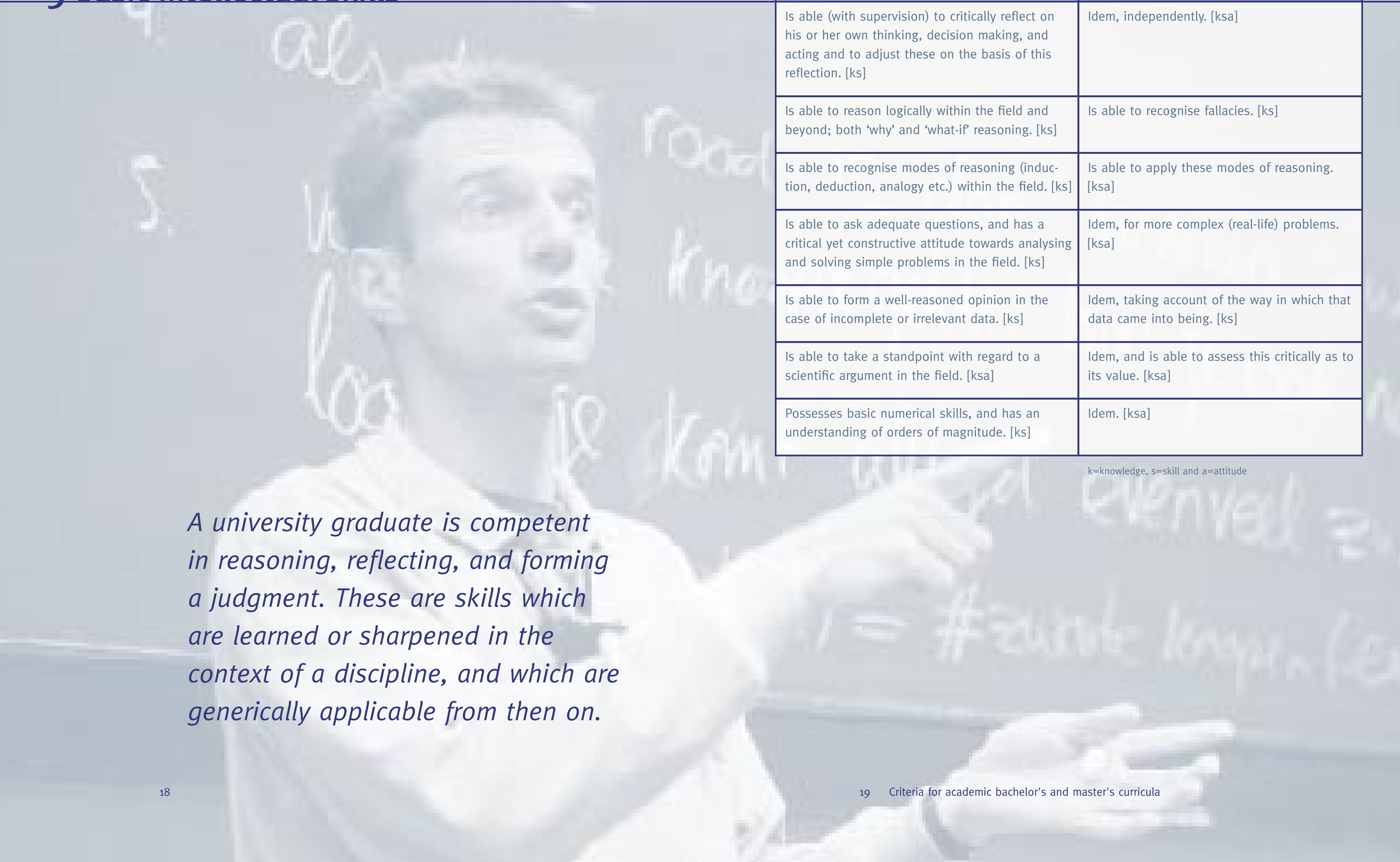
4 a scientific approach

A university graduate has a systematic approach characterised by the development and use of theories, models and coherent interpretations, has a critical attitude, and has insight into the nature of science and technology.

Bachelor	Master
Is inquisitive and has an attitude of lifelong learning. [ka]	Is able to identify and take in relevant developments. [ksa]
Has a systematic approach characterised by the development and use of theories, models and interpretations. [ksa]	Is able to critically examine existing theories, models or interpretations in the area of his or her graduation subject. [ksa]
Has the knowledge and the skill to use, justify and assess as to their value models for research and design (model understood broadly: from mathematical model to scale-model). Is able to adapt models for his or her own use. [ks]	Has great skill in, and affinity with the use, development and validation of models; is able consciously to choose between modelling techniques. [ksa]
Has insight into the nature of science and technology (purpose, methods, differences and similarities between scientific fields, nature of laws, theories, explanations, role of the experiment, objectivity etc.). [k]	Idem, and has knowledge of current debates about this. [k]
Has insight into the scientific practice (research system, relation with clients, publication system, importance of integrity etc.). [k]	Idem, and has knowledge of current debates about this. [k]
Is able to document adequately the results of research and design with a view to contributing to the development of knowledge in the field and beyond. [ksa]	Idem, and is able to publish these results. [ksa]

k=knowledge, s=skill and a=attitude

5 basic intellectual skills

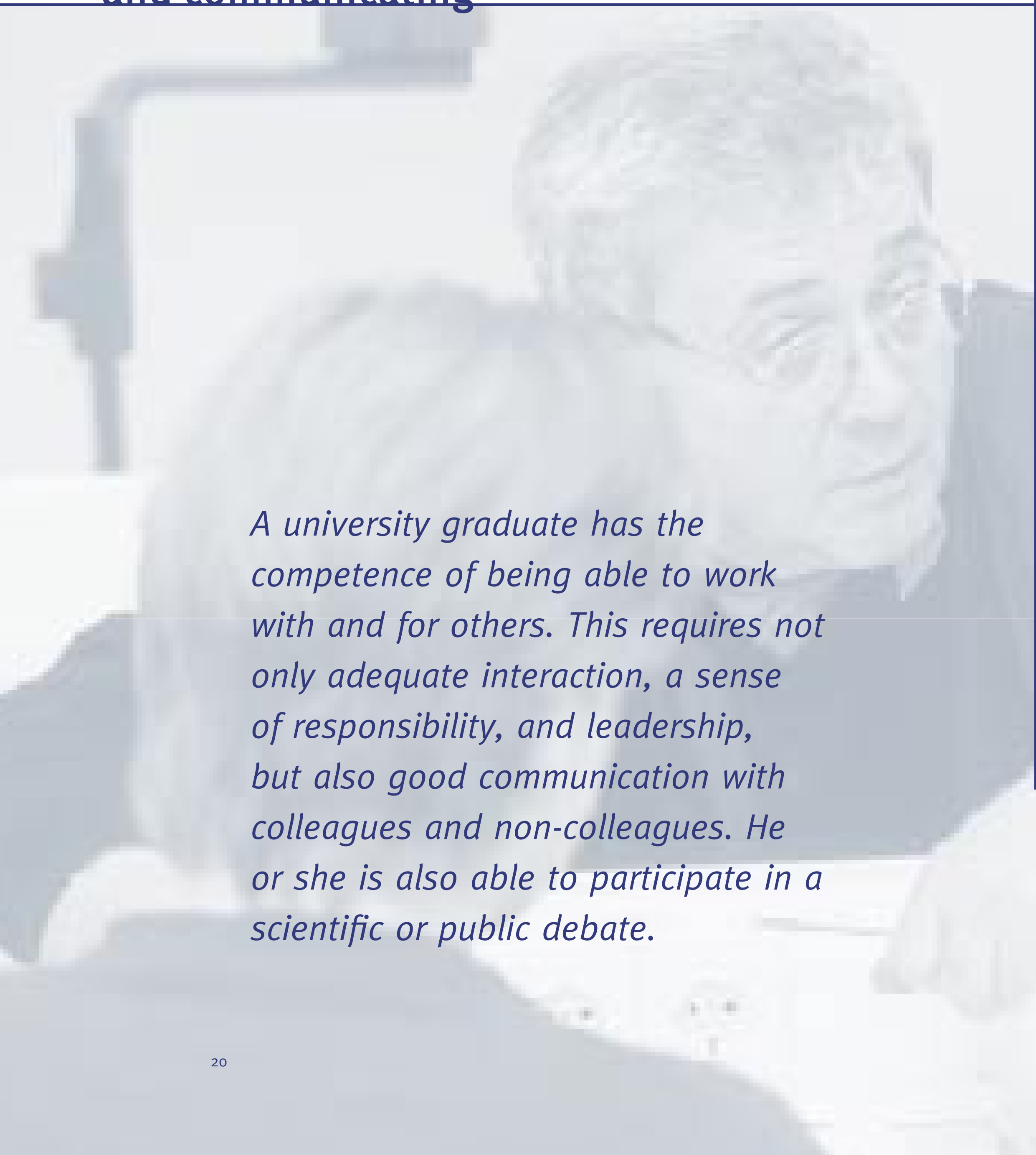


A university graduate is competent in reasoning, reflecting, and forming a judgment. These are skills which are learned or sharpened in the context of a discipline, and which are generically applicable from then on.

Bachelor	Master
Is able (with supervision) to critically reflect on his or her own thinking, decision making, and acting and to adjust these on the basis of this reflection. [ks]	Idem, independently. [ksa]
Is able to reason logically within the field and beyond; both 'why' and 'what-if' reasoning. [ks]	Is able to recognise fallacies. [ks]
Is able to recognise modes of reasoning (induction, deduction, analogy etc.) within the field. [ks]	Is able to apply these modes of reasoning. [ksa]
Is able to ask adequate questions, and has a critical yet constructive attitude towards analysing and solving simple problems in the field. [ks]	Idem, for more complex (real-life) problems. [ksa]
Is able to form a well-reasoned opinion in the case of incomplete or irrelevant data. [ks]	Idem, taking account of the way in which that data came into being. [ks]
Is able to take a standpoint with regard to a scientific argument in the field. [ksa]	Idem, and is able to assess this critically as to its value. [ksa]
Possesses basic numerical skills, and has an understanding of orders of magnitude. [ks]	Idem. [ksa]

k=knowledge, s=skill and a=attitude

6 competent in co-operating and communicating

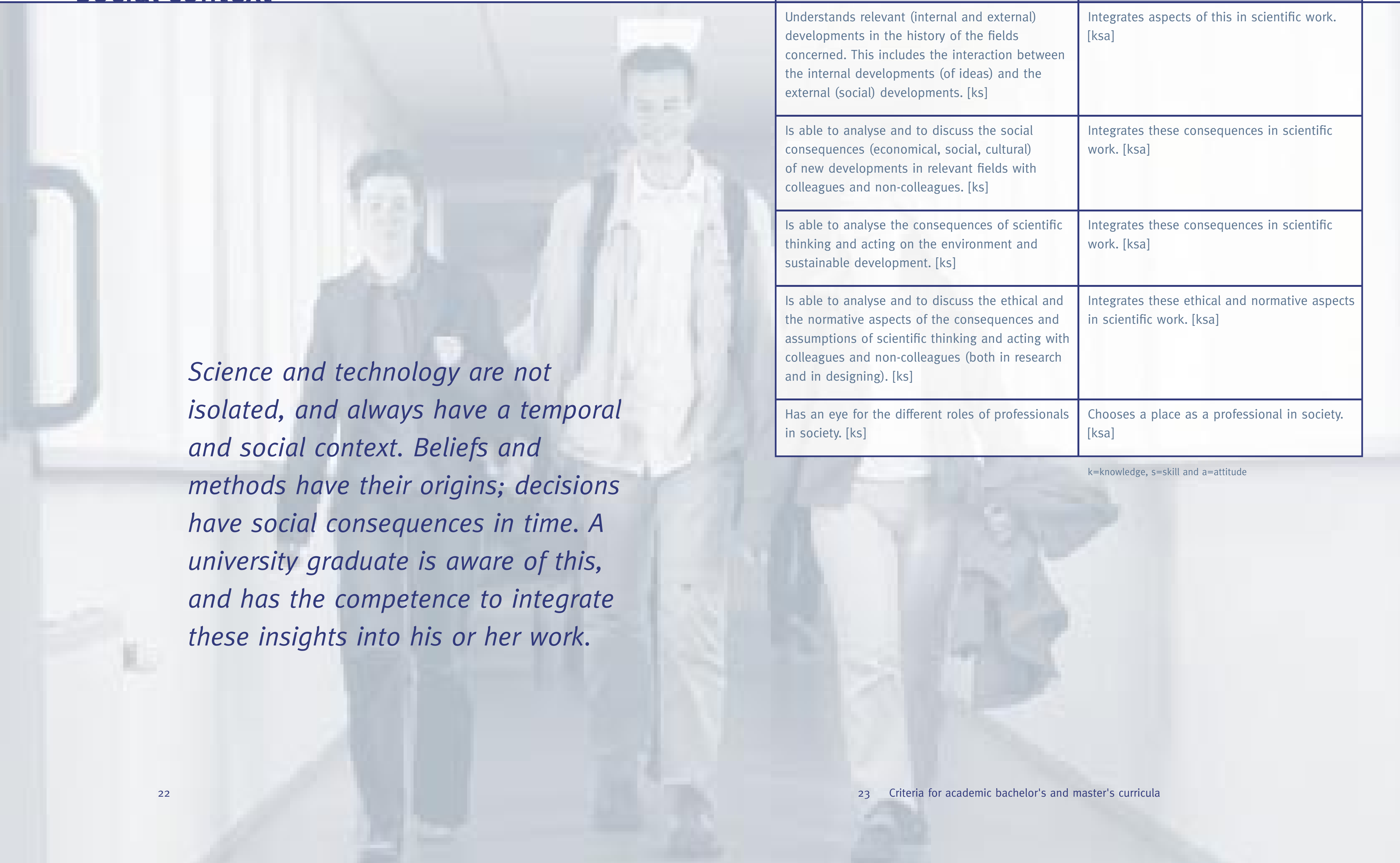


A university graduate has the competence of being able to work with and for others. This requires not only adequate interaction, a sense of responsibility, and leadership, but also good communication with colleagues and non-colleagues. He or she is also able to participate in a scientific or public debate.

Bachelor	Master
Is able to communicate in writing about the results of learning, thinking and decision making with colleagues and non-colleagues. [ks]	Is able to communicate in writing about research and solutions to problems with colleagues, non-colleagues and other involved parties. [ksa]
Is able to communicate verbally about the results of learning, thinking and decision making with colleagues and non-colleagues. [ks]	Is able to communicate verbally about research and solutions to problems with colleagues, non-colleagues and other involved parties. [ksa]
Idem to above (verbally and in writing), but in a second language. [ks]	Idem to above (verbally and in writing), but in a second language. [ksa]
Is able to follow debates about both the field and the place of the field in society. [ks]	Is able to debate about both the field and the place of the field in society. [ksa]
Is characterised by professional behaviour. This includes: drive, reliability, commitment, accuracy, perseverance and independence. [ksa]	Idem. [ksa]
Is able to perform project-based work: is pragmatic and has a sense of responsibility; is able to deal with limited sources; is able to deal with risks; is able to compromise. [ksa]	Idem, for more complex projects. [ksa]
Is able to work within an interdisciplinary team. [ks]	Idem, for a team with great disciplinary diversity. [ksa]
Has insight into, and is able to deal with, team roles and social dynamics. [ks]	Is able to assume the role of team leader. [ks]

k=knowledge, s=skill and a=attitude

7 takes account of the temporal and social context



Science and technology are not isolated, and always have a temporal and social context. Beliefs and methods have their origins; decisions have social consequences in time. A university graduate is aware of this, and has the competence to integrate these insights into his or her work.

Bachelor	Master
Understands relevant (internal and external) developments in the history of the fields concerned. This includes the interaction between the internal developments (of ideas) and the external (social) developments. [ks]	Integrates aspects of this in scientific work. [ksa]
Is able to analyse and to discuss the social consequences (economical, social, cultural) of new developments in relevant fields with colleagues and non-colleagues. [ks]	Integrates these consequences in scientific work. [ksa]
Is able to analyse the consequences of scientific thinking and acting on the environment and sustainable development. [ks]	Integrates these consequences in scientific work. [ksa]
Is able to analyse and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting with colleagues and non-colleagues (both in research and in designing). [ks]	Integrates these ethical and normative aspects in scientific work. [ksa]
Has an eye for the different roles of professionals in society. [ks]	Chooses a place as a professional in society. [ksa]

k=knowledge, s=skill and a=attitude