Outcomes Analysis of a New Informatics Curriculum

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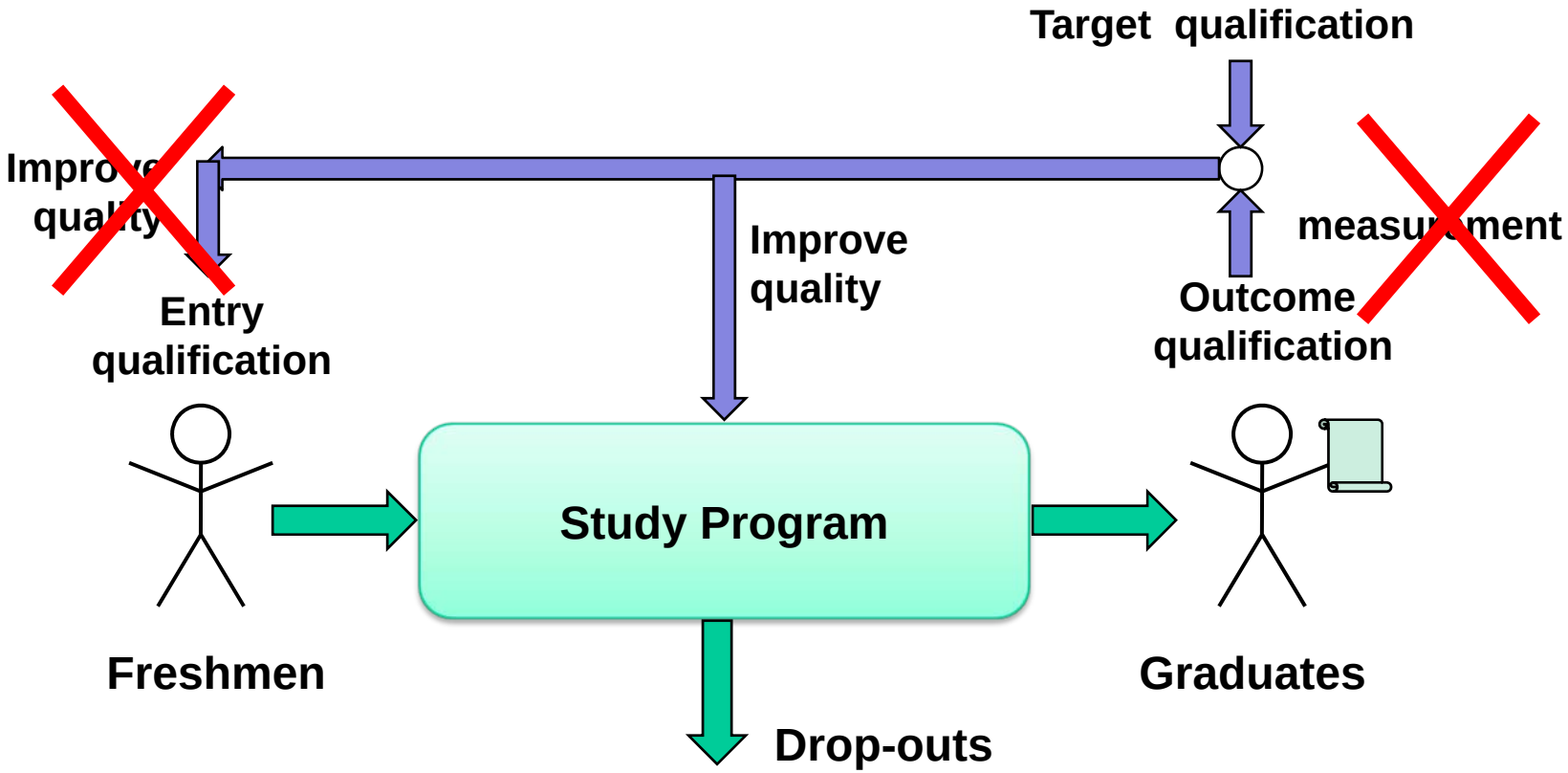
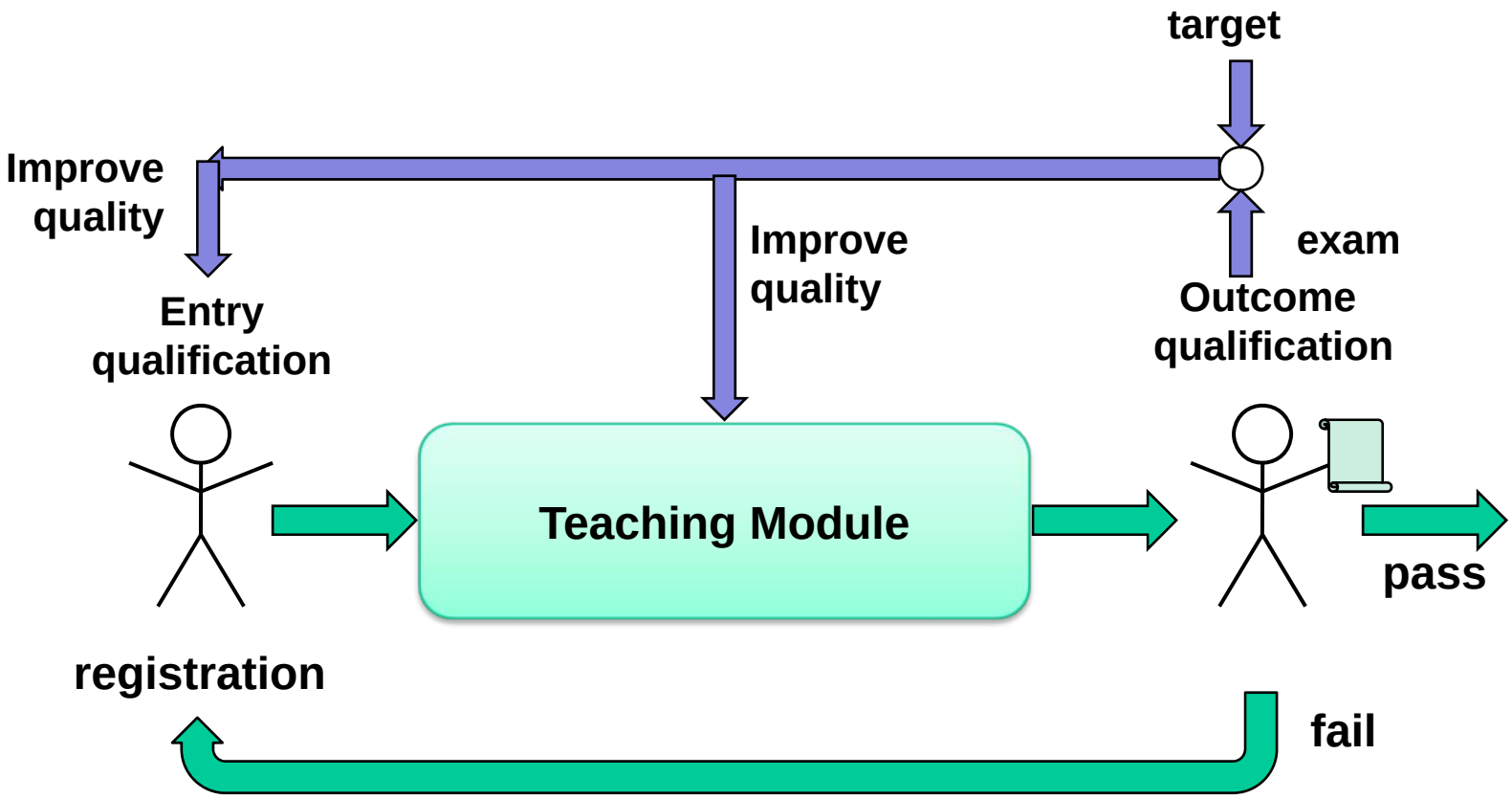
Goals

1. Analysis of a study program‘s competence profile
2. Evidence, that study program produces graduates with the intended competence profile
3. (Enforced reflection about competence goals)

Education Process

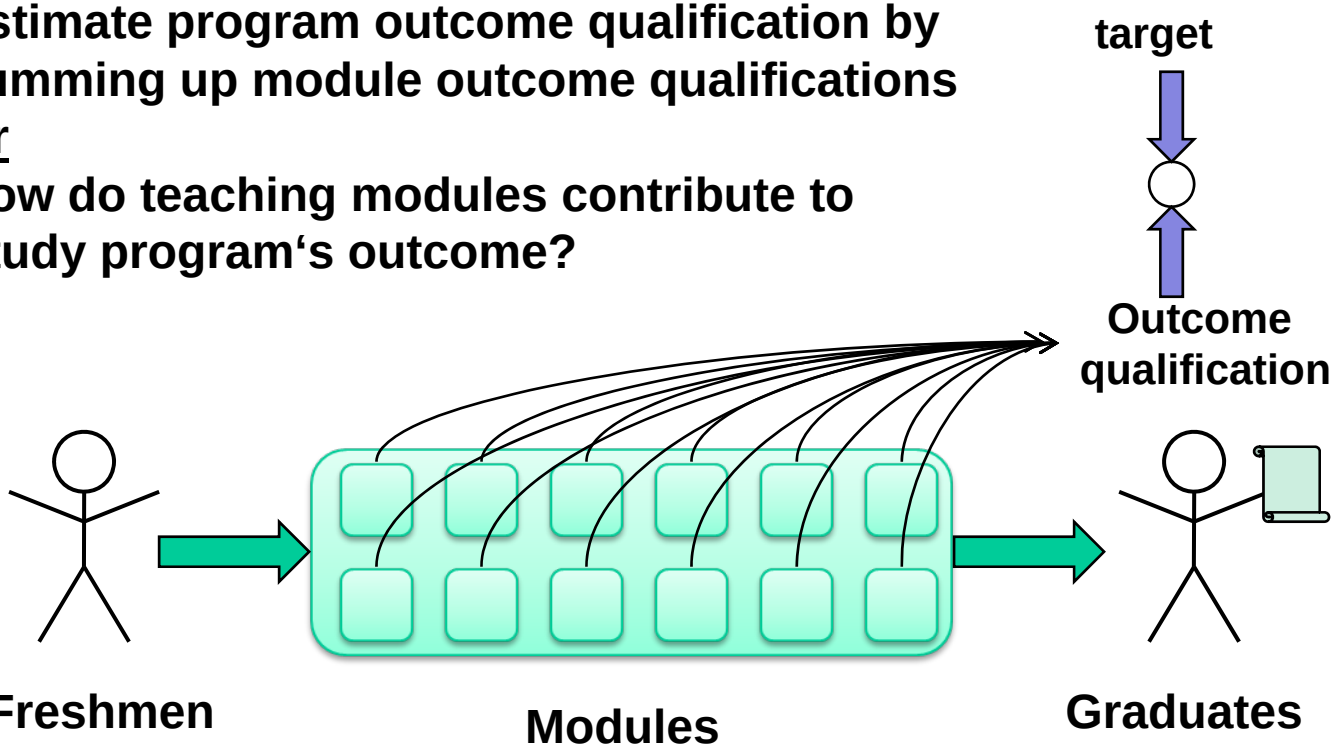


Education Process at Course Level



Approach

Estimate program outcome qualification by summing up module outcome qualifications
<u>Or</u>
How do teaching modules contribute to Study program‘s outcome?



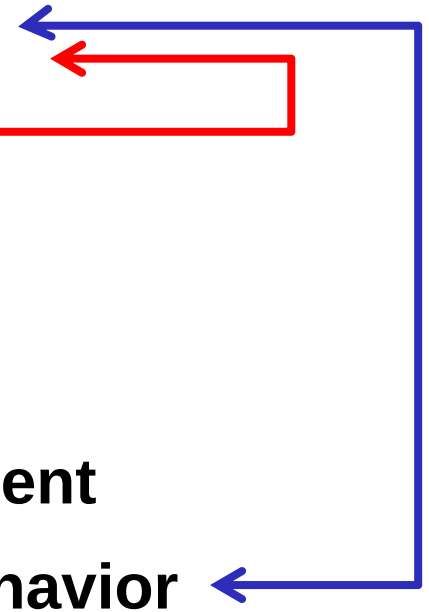
ACQA[1]-Method

- Developed by TU Eindhoven
- Adopted by TU9 (German Institutes of Technology) and applied to several study programs at TU9 universities

1) **A**cademic **C**ompetences and **Q**uality **A**ssurance
http://w3.tm.tue.nl/uploads/media/AC_ENG_web.pdf

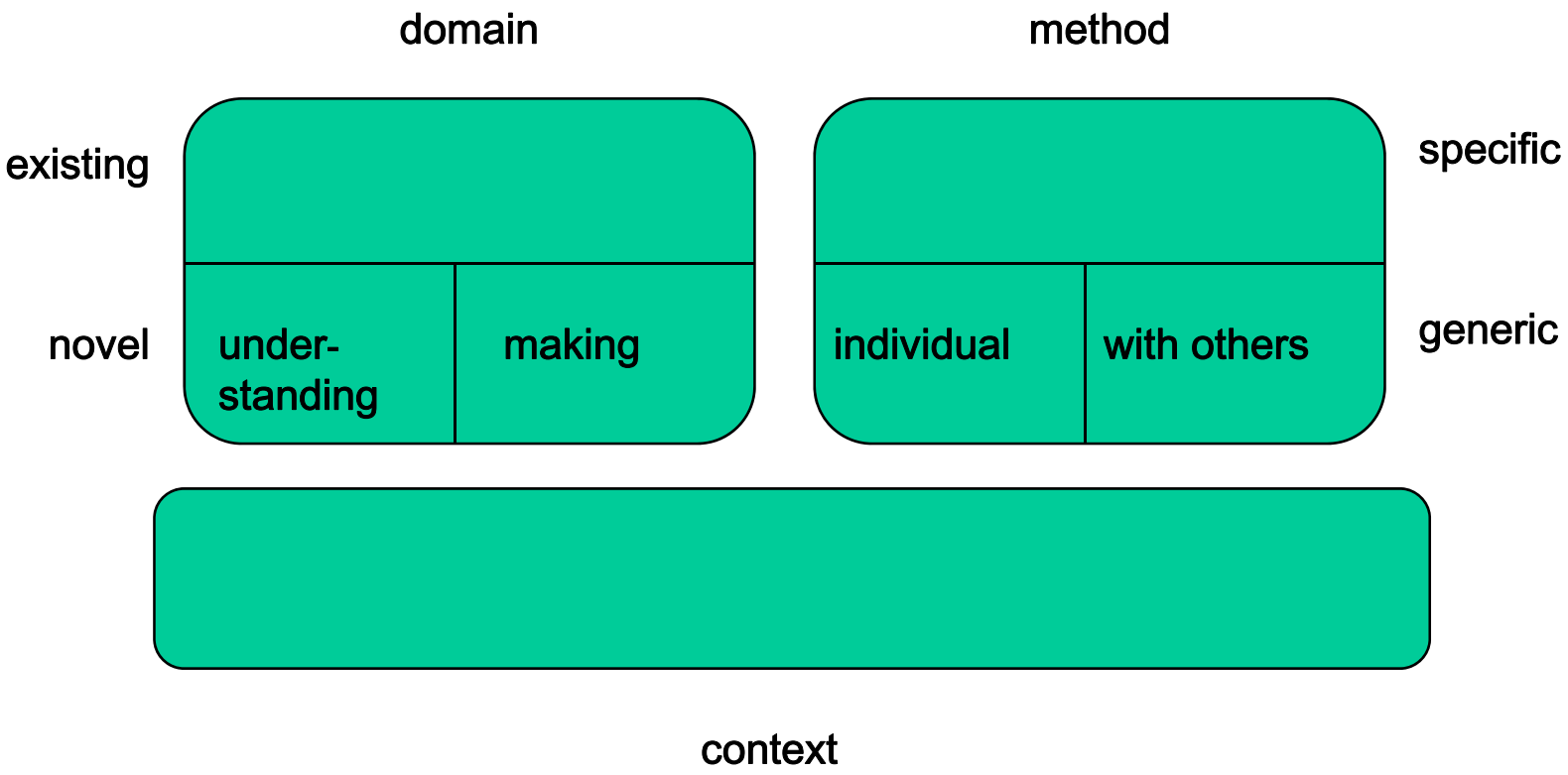
Conceptual Framework (competences)

Stages



Source: K. v. Overveld

Conceptual Framework (competences)



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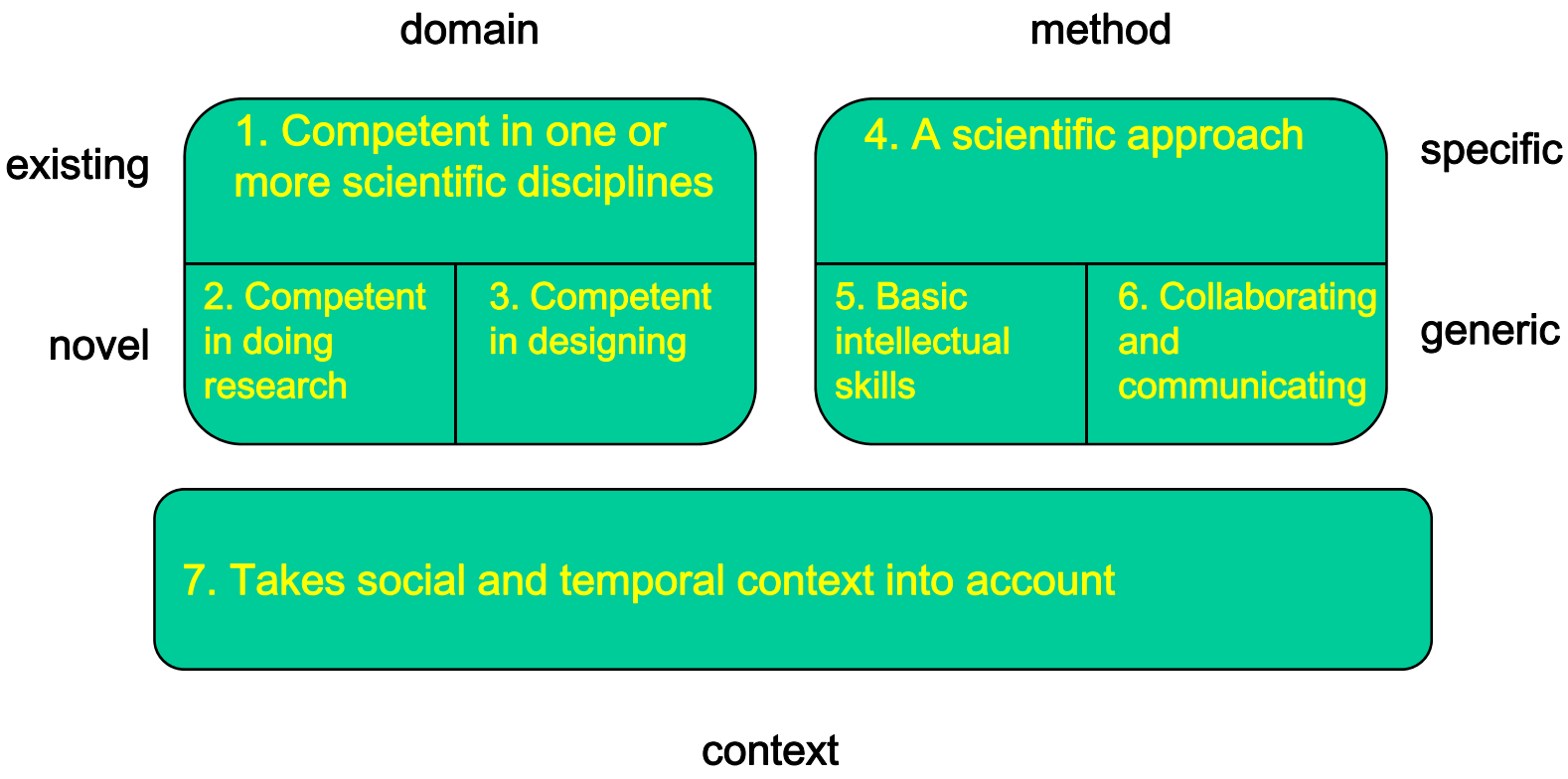
Conceptual Framework (competences)



Source: K. v. Overveld

Bachelors	Is examined	Is addressed	Masters	Is examined	Is addressed
1. Competent in one or more scientific disciplines:			**percentage study load: min % max %**		
Understands knowledge base of relevant areas (theories, methods, ...)			Forefront of knowledge (latest theories, methods, ...)		
Understands the structure and connections among sub-fields			Looks actively for structure and connections		
Truth-finding, development of theories and models	√	√	Independently, more advanced cases		
interpretation (texts, data, problems, ...)			Independently, more advanced cases		
Experiments, data acquisition, simulation			Independently, more advanced cases		
Decision-making			Independently, more advanced cases		
Presuppositions of standard methods and their importance			Reflection on standard methods		
Revise and extend own knowledge (under supervision)	√		Independently		
2. Competent in doing research:			**percentage study load: min % max %**		
Reformulate ill-structured research problems			Idem, for problems of more complex nature		
Observant, has the creativity to discover new viewpoints			Ability to put new viewpoints into practice for new applications		
Able to develop and execute research plan (under supervision)			Independently		
Able to work at different levels of abstraction			Chooses the right level of abstraction		
Understands the importance of other disciplines, where relevant			Involves other disciplines		
Is aware of the changeability of the research process	√		Deals with changeability, able to steer the process		
Able to assess research within the discipline on its usefulness	√		Able to assess research on its scientific value	√	
Contribute to the development of scientific knowledge (supervision)	√		Independently		√
3. Competent in designing:			**percentage study load: min % max %**		
Reformulate ill-structured design problems			Idem, for problems of more comples nature		
Creativity and synthetic skills			Idem		
Able to develop and execute design plan (under supervision)			Independently		
Able to work at different levels of abstraction (inc. System level)			Chooses the right level of abstraction		
Understands the importance of other disciplines, where relevant			Involves other disciplines		
Is aware of the changeability of the design process			Deals with changeability, able to steer the process		
Knowledge integration in a design			Able to formulate new research questions in a design		
Take, justify and evaluate design decisions in a systematic way			Idem		

Bachelors	Is examined / Is addressed	Masters	Is examined / Is addressed
4. A scientific approach:	percentage study load: min % max %		
Inquisitive, an attitude of life long learning		Identify and take in relevant developments	
Systematic approach (develop and use theories, models. …)		Critically examines existing theories in the area of graduation	
Use, justify and assess models for research and design		Develop and validate models; chose modelling technique	
Insight in the nature of science and technology		Idem; current debates	
Insight in scientific practice (research system, ...)		Idem; current debates	
Adequate documentation		Idem; publication	
5. Basic intellectual skills:	percentage study load: min % max %		
Critical reflection (own thinking, deciding, acting,…)		Idem, independently	
Logical reasoning (within the field and beyond)		Able to recognise fallacies	
Recognise modes of reasoning (deduction, induction, …)		Able to apply modes of reasoning	
Able to ask questions, critical / constructive attitude		Idem for more complex (real-life) problems	
Deal with incomplete or irrelevant data		Idem, taking acount of the origin of the data	
Take a standpoint with regard to scientific argument		Idem, able to assess this critically	
Basic numeric skills, understands orders of magnitudes		Idem	
6. Competent in collaboration and communication:	percentage study load: min % max %		
Able to communicate in writing on results of learning, thinking, …		Able to communicate in writing on research and solutions	
Able to communicate verbally on results of learning, thinking, …		Able to communicate verbally on research and solutions	
Mastering of a second language		Idem; attitude aspect	
Able to follow debates about the field and its societal place		Idem; attitude aspect	
Characterised by professional behaviour		Idem	
Able to perform project-based work		Idem; for more complex projects	
Able to work within interdisciplinary team		Idem; larger disciplinary variety	
Deal with team roles and social dynamics		Able to assume the role of team leader	
7. Takes account of temporal and social context:	percentage study load: min % max %		
Understands relevant developments in the history of the field		Integrates developments in scientific work	
Analyses societal consequences		Integrates consequences in scientific work	
Analyses environmental and sustainability issues		Integrates consequences in scientific work	
Analyses normative and ethic aspects		Integrates these aspects in scientific work	
Has an eye for the different roles of professionals		Chooses a place as a professional in society	

Technische Universität Berlin

Application of Method to Computer Science Curriculum at TU Berlin

Technische Universität Berlin

CP	Bachelor's Program in Computer Science					
1st Sem. 29 CP	Digital Systems (6 CP)	Algorithmic and Functional Solution of Discrete Problems (9 CP)		Found. and Algebraic Structures (6 CP)	Scientific Prep course 2 CP)	Linear Algebra (6 CP)
2nd Sem. 29 CP	Computer Organization (6 CP)	Data Structures and Algorithms in Imperative Style (9 CP)		Automata and Complexity (6 CP)		Calculus I (8 CP)
3rd Sem. 32 CP	System Programming (6 CP)	Software Engineering (12 CP) Including Project	Practical Program Development (6 CP)	Logic and Calculi (6 CP)		Calculus II (8 CP)
4th Sem. 30 CP	Networks and Distributed Systems (6 CP)		Database Systems (6 CP)	Specification and Semantics (6 CP)		Stochastics (6 CP)
5th Sem. 30 CP	Computer Science Electives (21-24 CP) Software Technology or Communication Technology		Minor Studies (12-15 CP)			Management (6 CP)
6th Sem. 30 CP			Bachelor's Thesis (12 CP)			Social Aspects of CS (6 CP)

<table>
<tr><th>CP</th><th colspan="3">Master’s Program in Computer Science (Basic Structure)</th></tr>
<tr><td>1st
30 CP</td><td rowspan="3">Major Studies (54 - 60 CP)
including at least 30 CP
in the specialization area:
◆ System Engineering
◆ Dependable Systems
◆ Intelligent Systems
◆ Communication Systems</td><td rowspan="3">Minor Studies
(18 - 24 CP)</td><td rowspan="3">General Studies
(12-18 CP)</td></tr>
<tr><td>2nd
30 CP</td></tr>
<tr><td>3rd
30 CP</td></tr>
<tr><td>4th
30 CP</td><td colspan="3">Master’s Thesis(30 CP)</td></tr>
</table>

- System Engineering: Software Engineering, Programming Language Design, Computer Organization, Operating Systems, Performance Evaluation, Information Systems, System Analysis, Enterprise Arch.
- Dependable Systems: Component-Based Modeling, Specification Tools, Semantics and Calculi, Security&Trust, Realtime Systems, Correctness, Testing, Fault-tolerance,…
- Intelligent Systems: Neural Information Processing, Bio-Informatics, Intelligent Data Analysis, Computer Graphics, Computer Vision, Robotics, Artificial Intelligence, Agent Oriented Systems,...
- Communication-based Systems: Communication Networks, Protocol Design, Mobile Communication, Ambient Intelligence, Next Generation Networks, (Open) Distributed Systems, SOA,…

Procedure:

1. Interview with lecturers
2. Guided answering of a questionnaire
3. Independent answering of additional module questionnaires via web interface

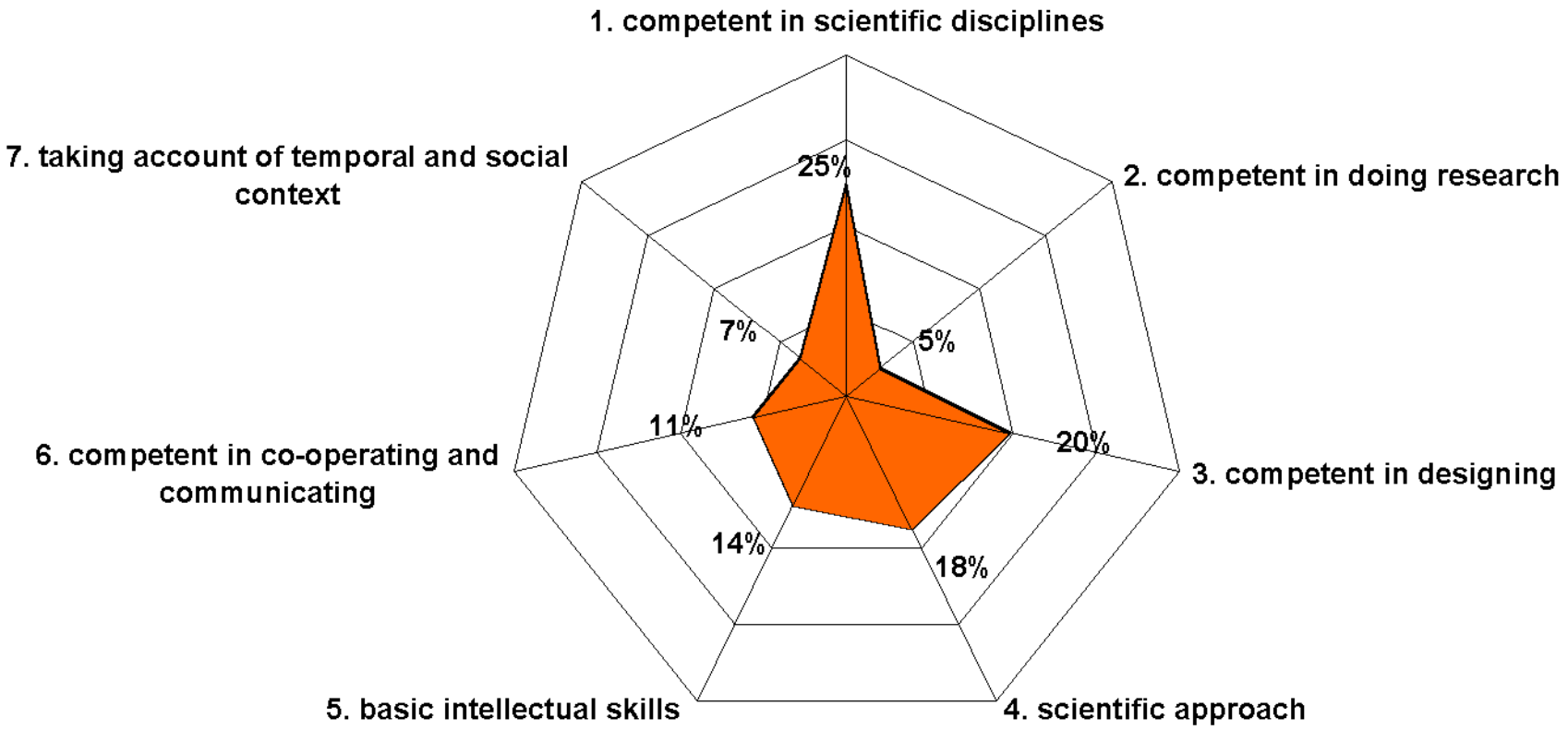
Extent of survey:

70 Modules, including:

- all mandatory modules
- Selected representative modules from specialization areas (electives)
- Bachelor and Master thesis

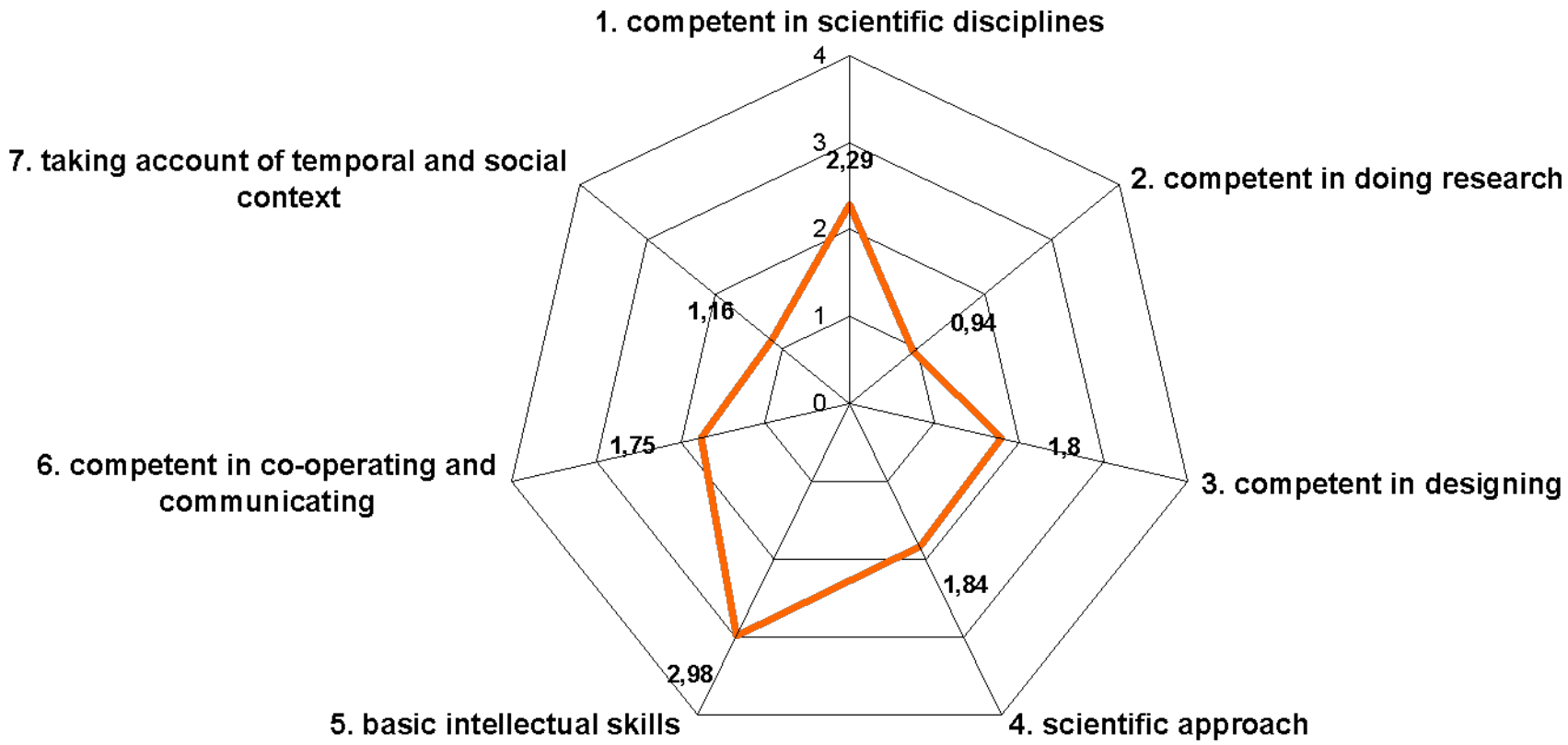
Competence Profile: Bachelor Programme Computer Science

percentage of workload (N=37)



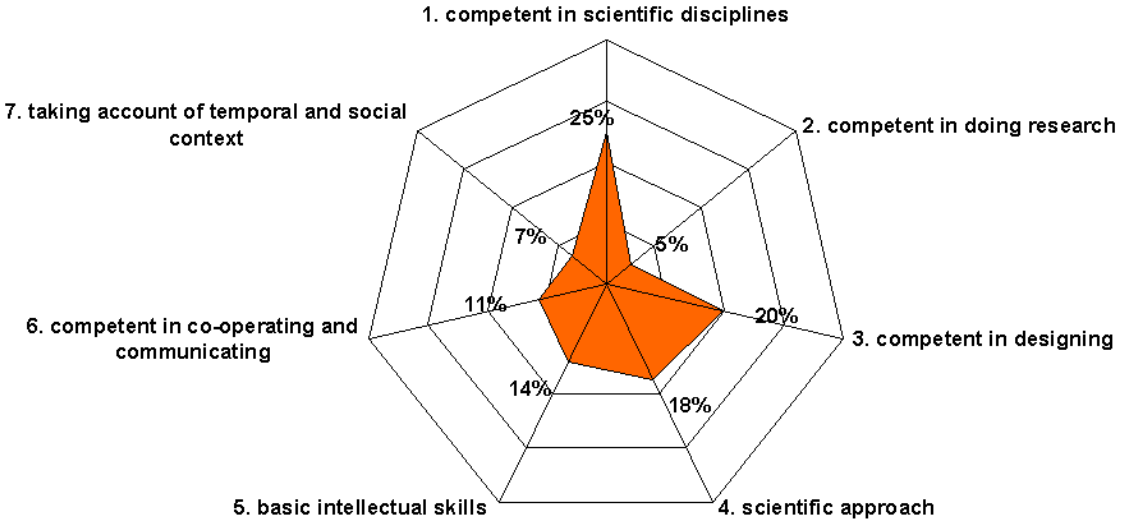
Levels of Competences: Bachelor Programme Computer Science

mean values of competences (N=37)

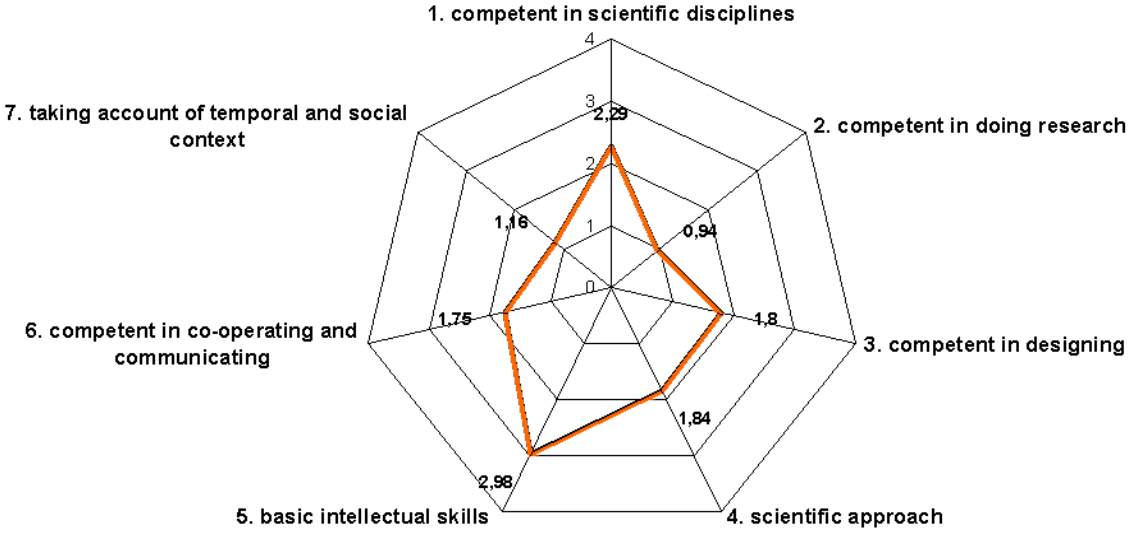


The levels of competences (1-5) describe the degree of requirements and the degree of complexity as well as the extent of the necessary responsiblity in fulfilling the study task. (Roscher/Sachs: 1999)

Competence Profile (percentage of work load)



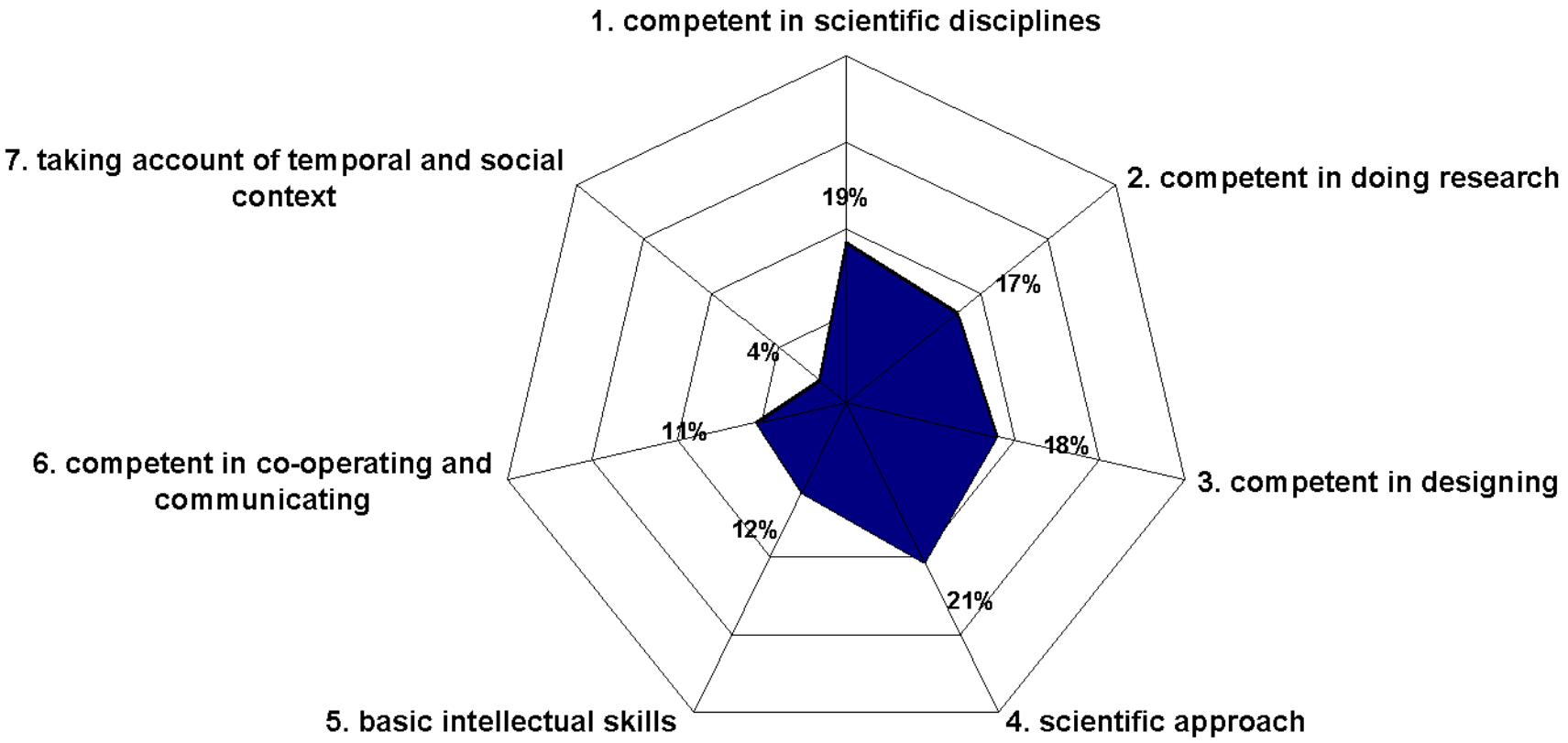
Levels of Competences (mean values)



Computer Science (BA)

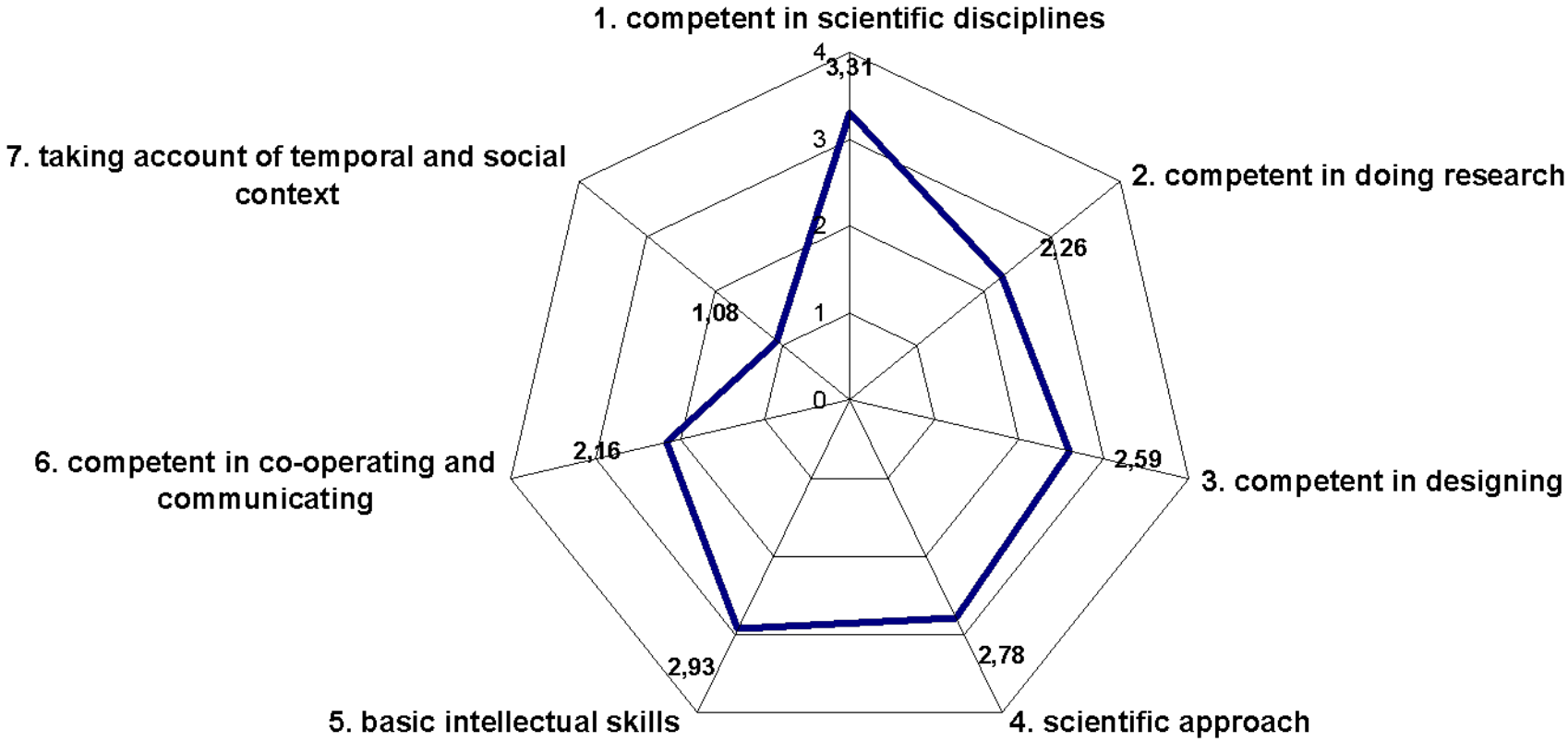
Competence Profile: Master Programme Computer Science

percentage of workload (N=33)



Levels of Competences: Master Programme Computer Science

mean values of competences (N=33)



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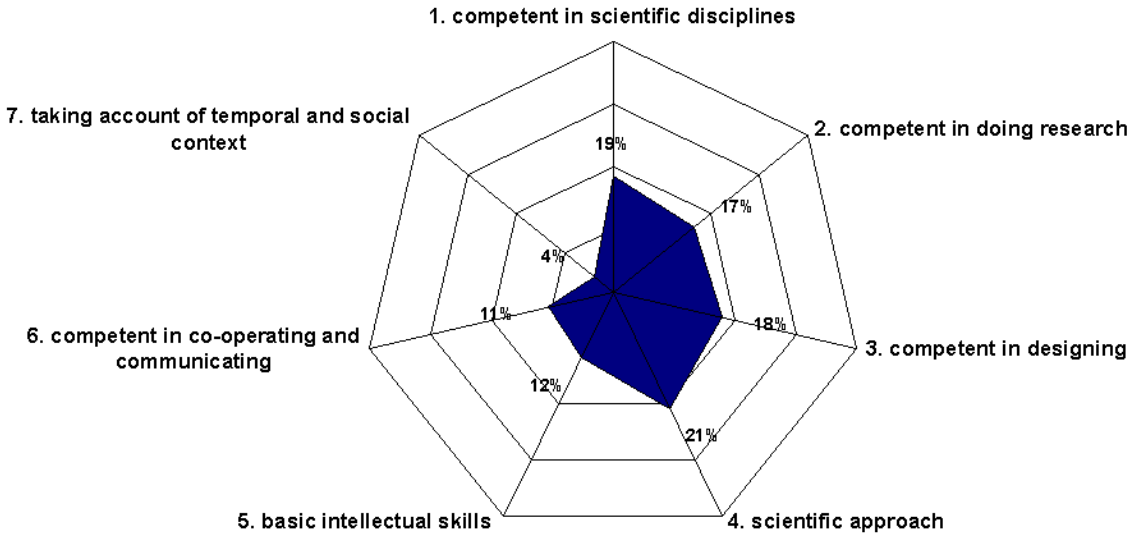
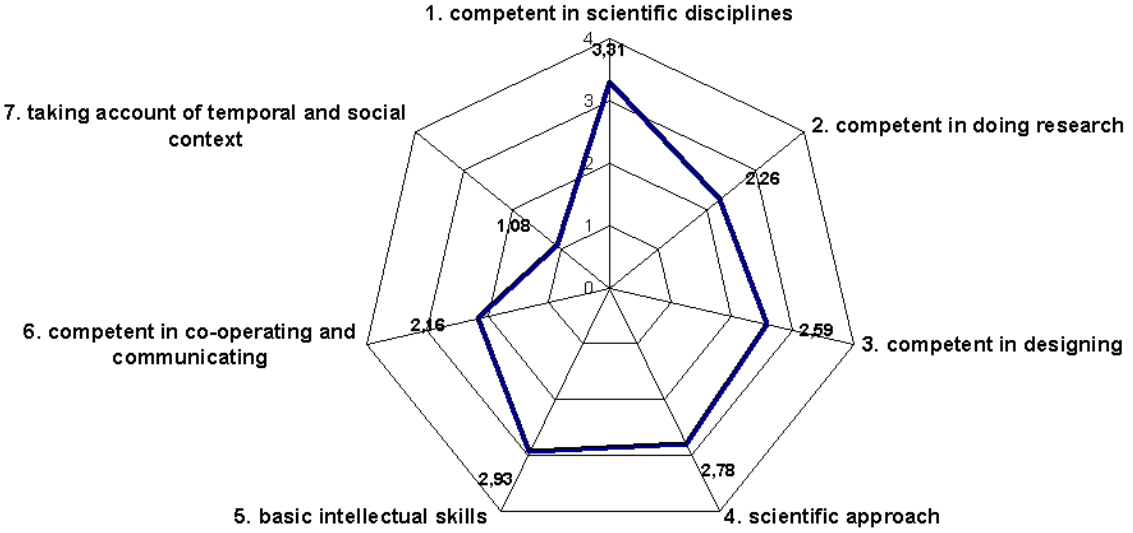
Competence Profile (percentage of work load)

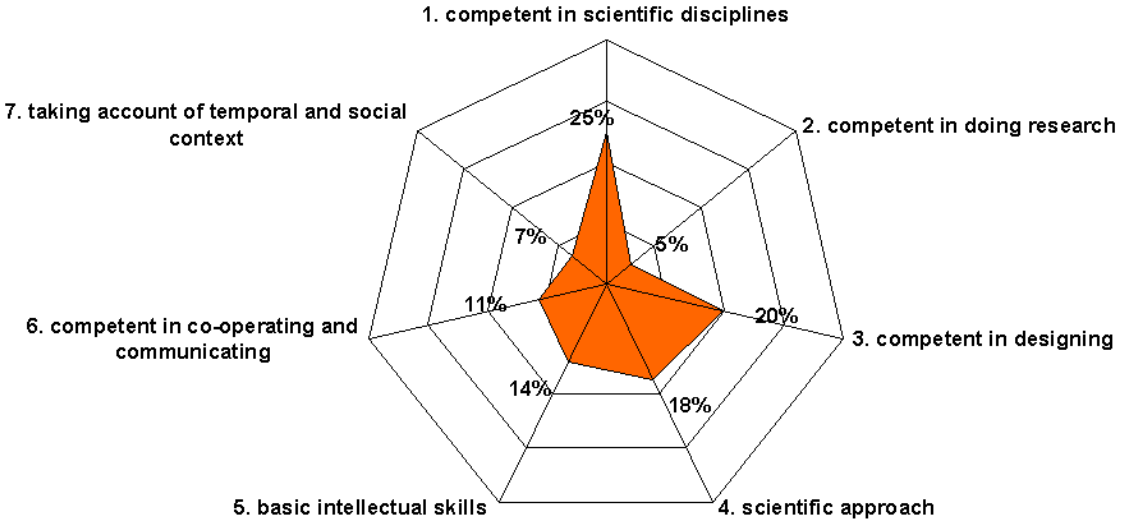


Levels of Competences (mean values)

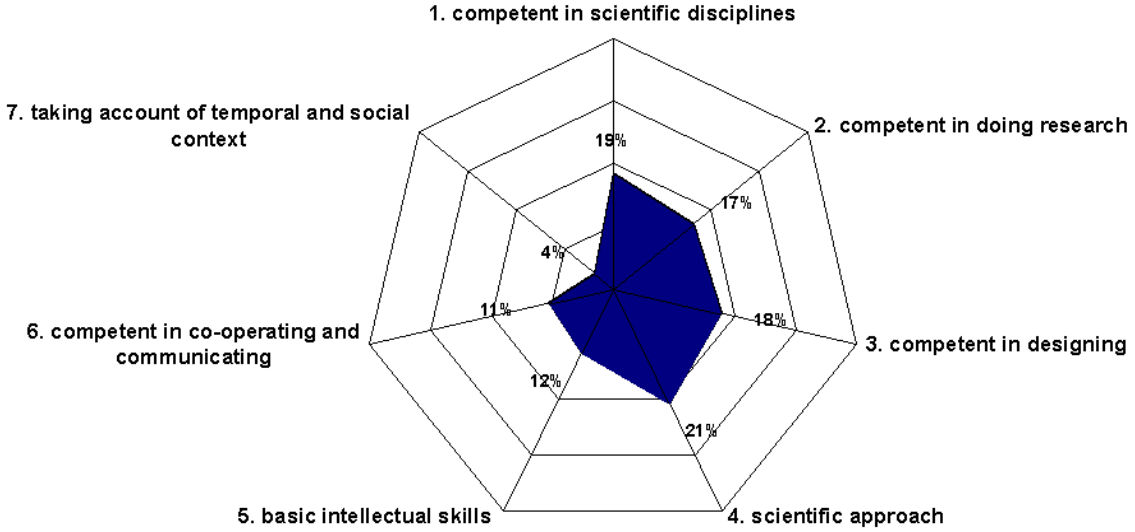


Computer Science (MA)

Bachelor Profile (percentage of work load)



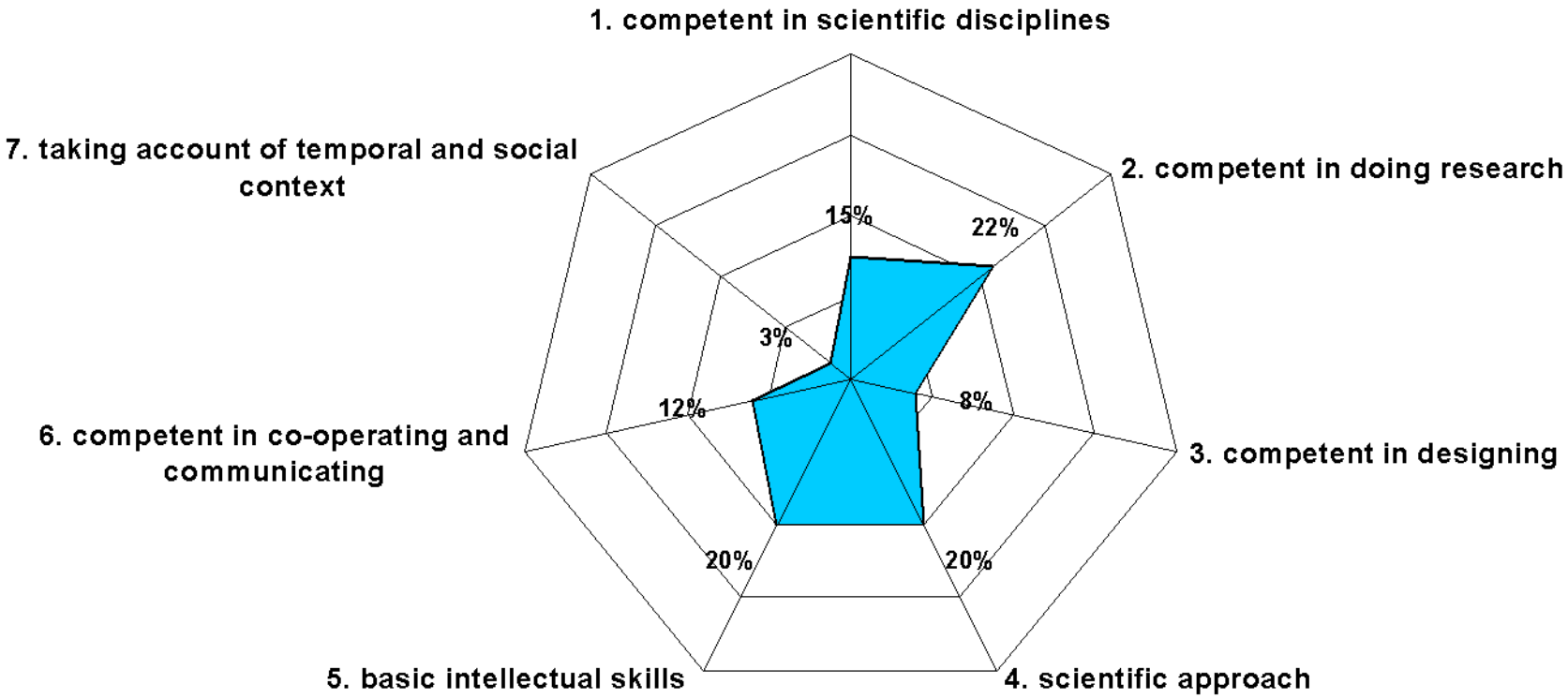
Master Profile (percentage of work load)



Competence Profile: Dependable Systems

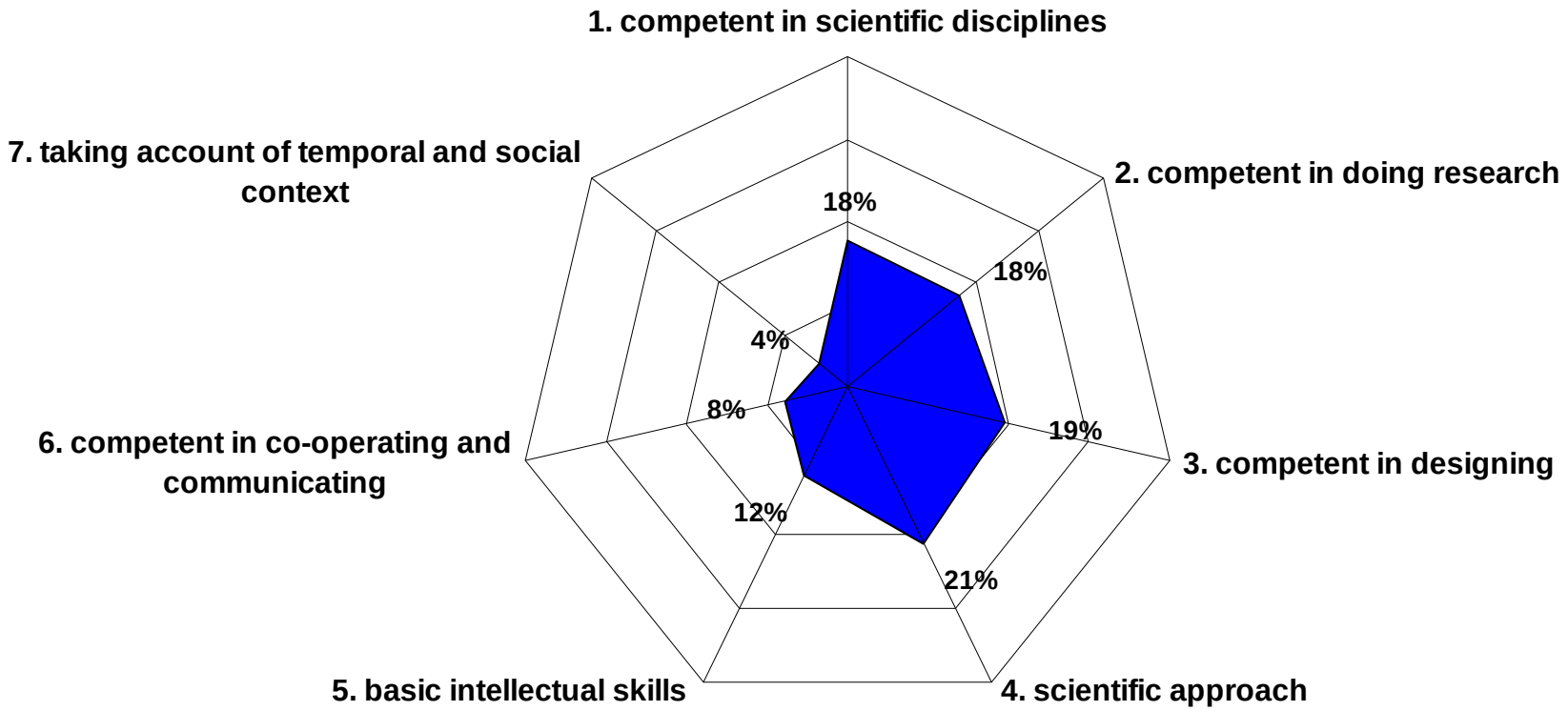
Computer Science, MA

percentage of workload (N=6)



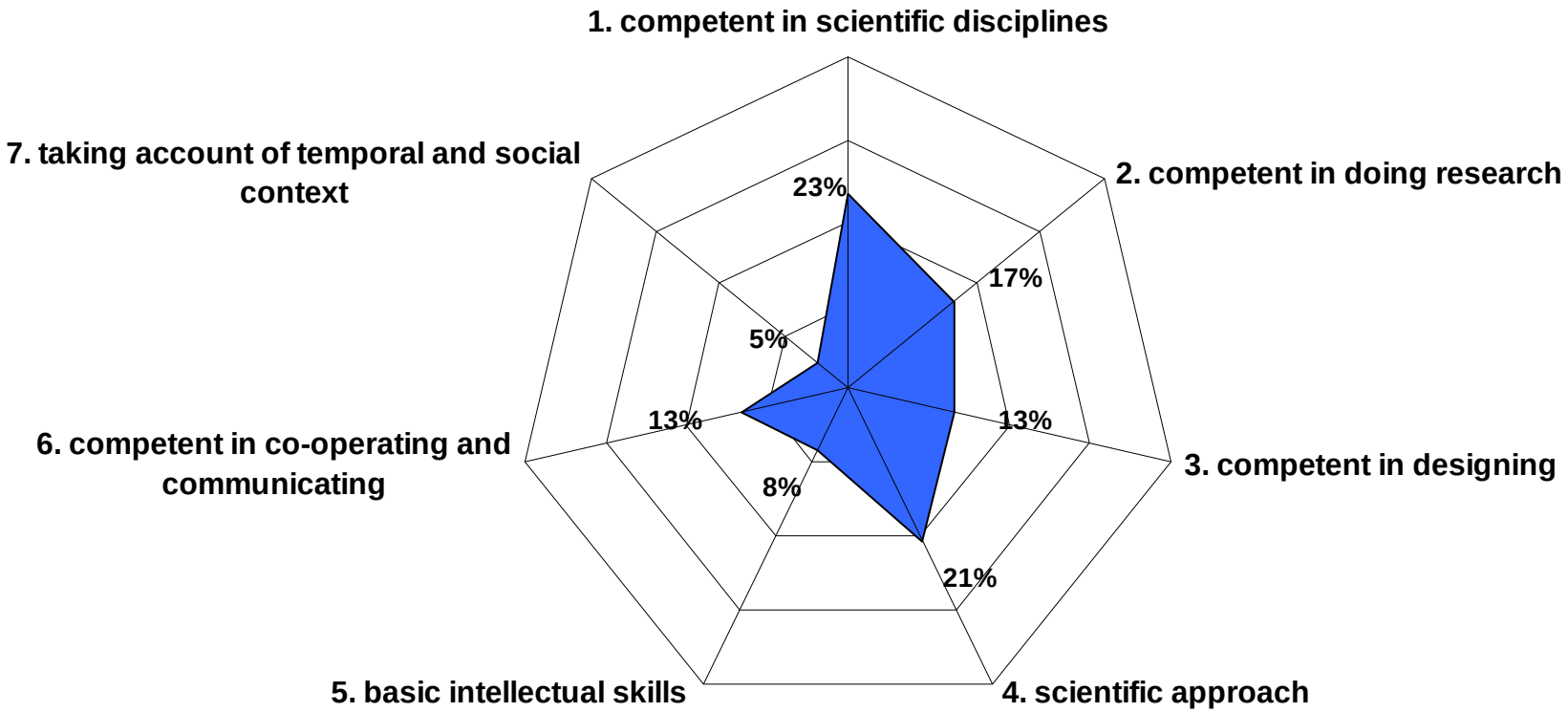
Competence Profile: Communication Based Systems Computer Science, MA

percentage of workload (N=9)



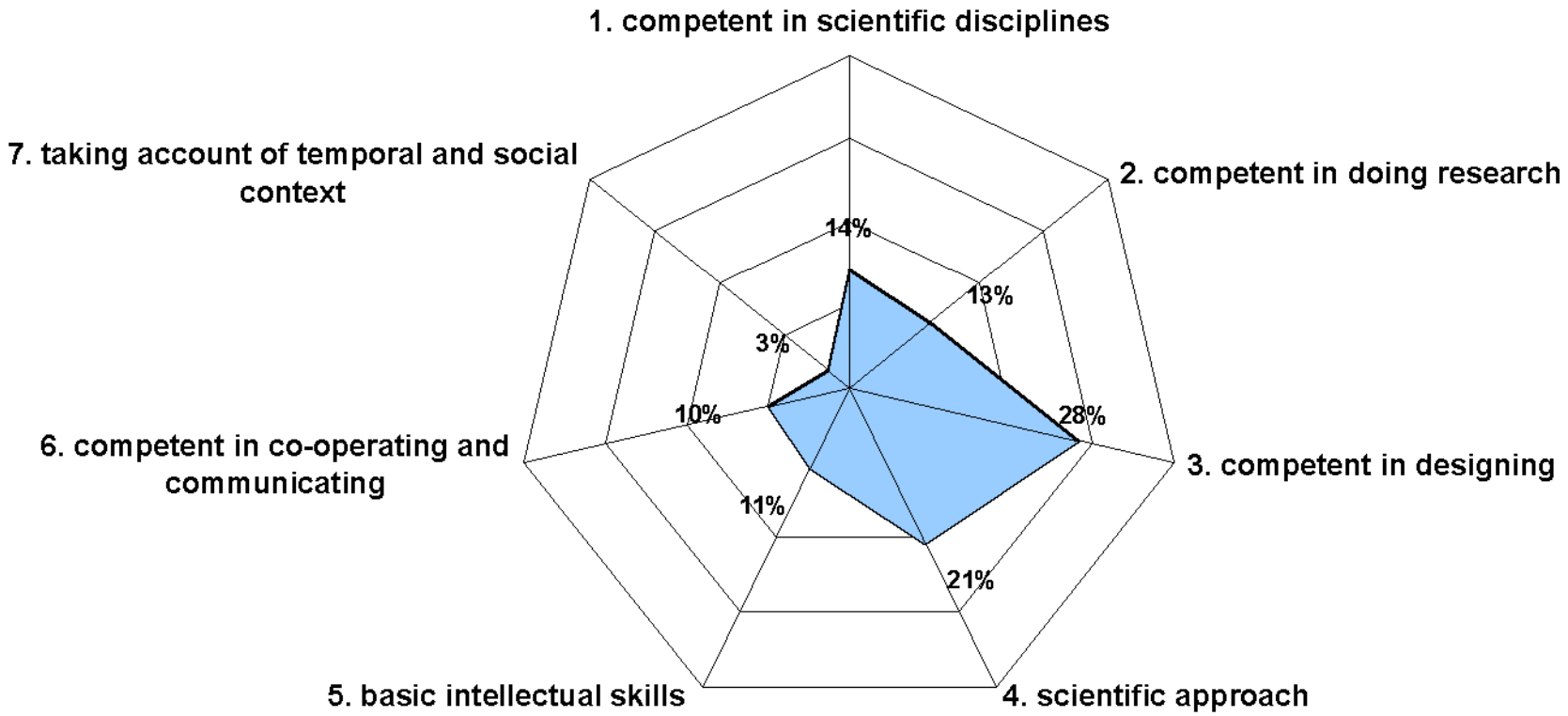
Competence Profile: Intelligent Systems
Computer Science, MA

percentage of workload (N=11)



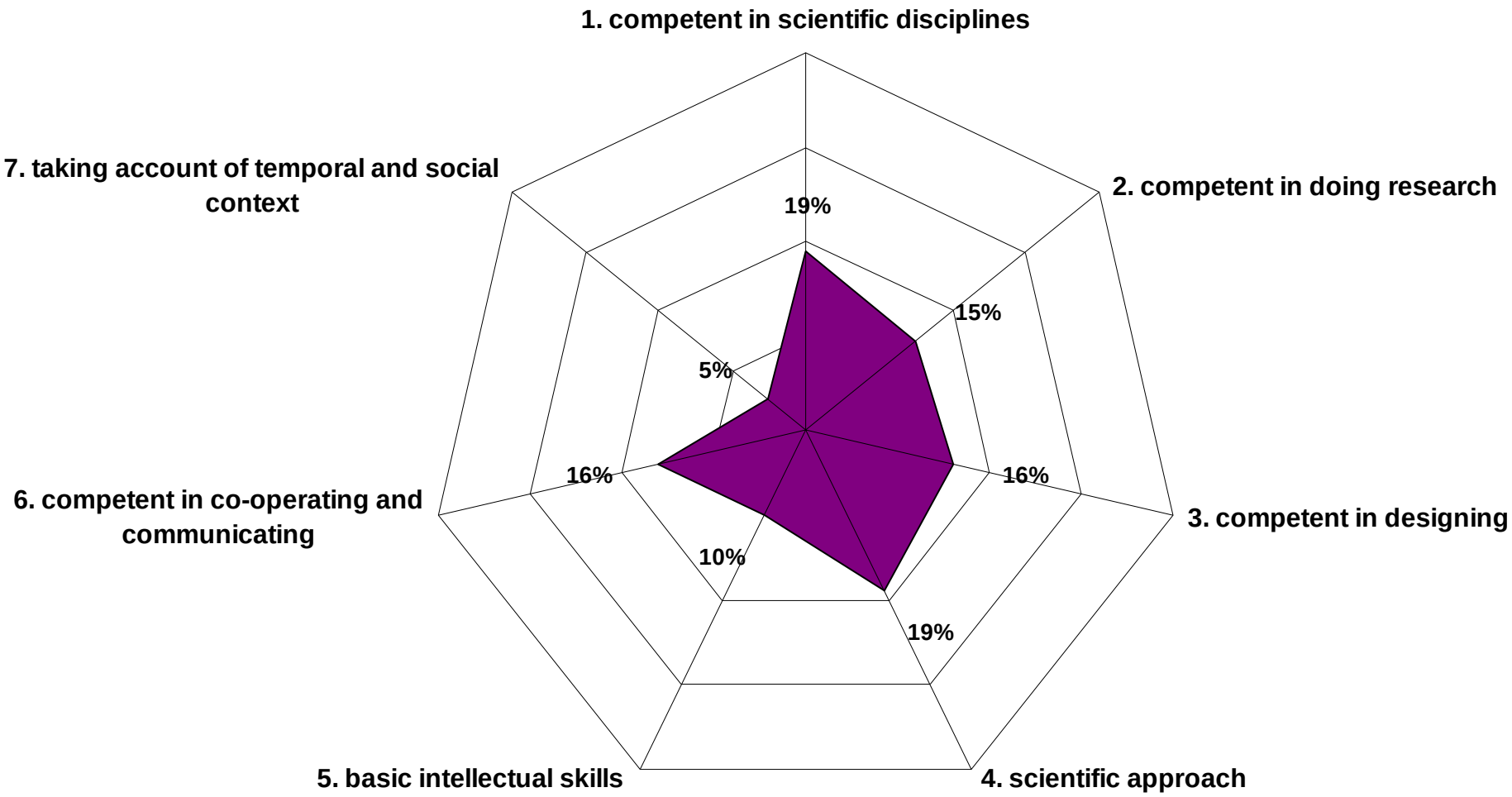
Competence Profile: System Engineering
Computer Science, MA

percentage of workload (N=6)

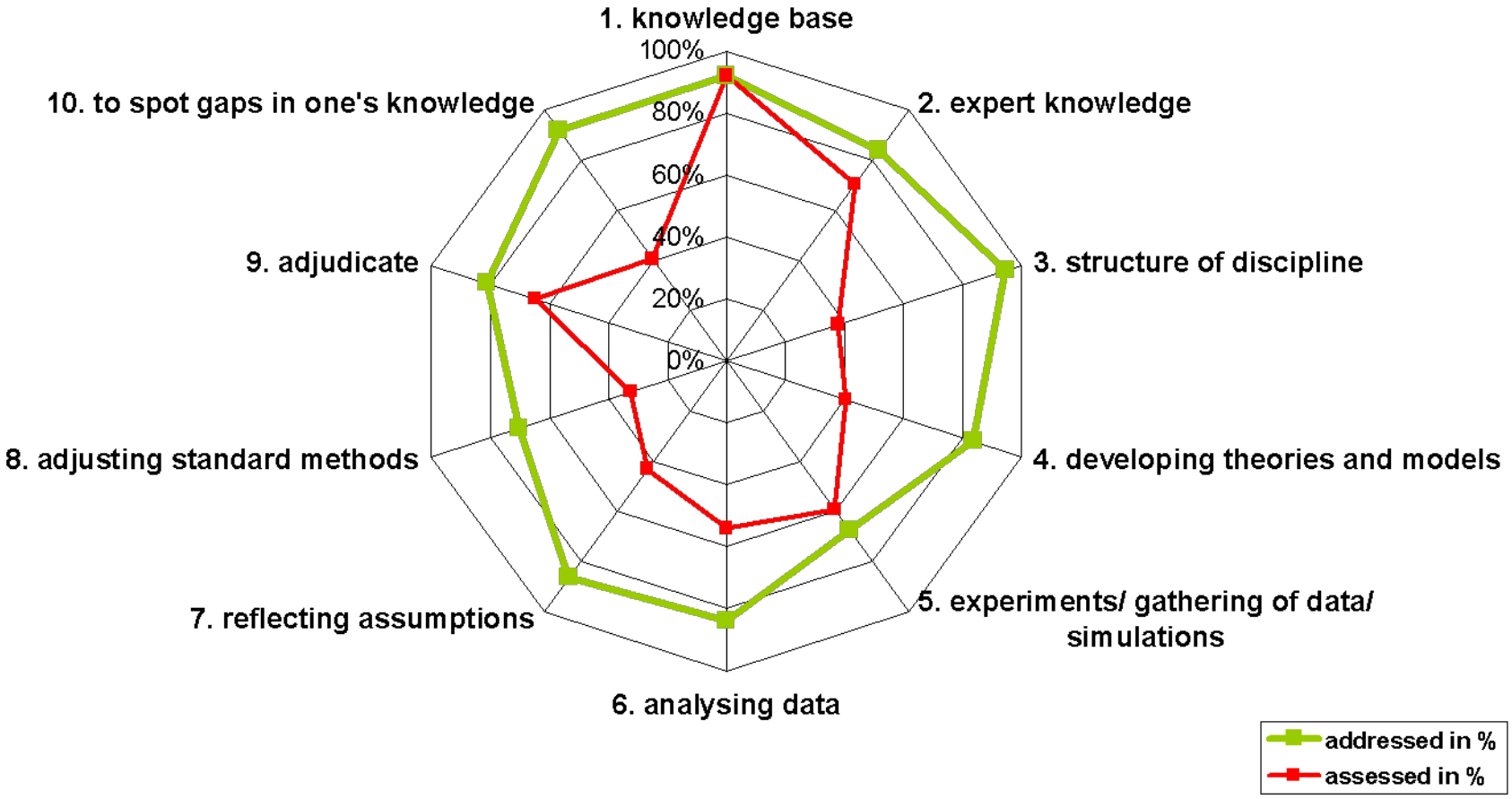


Competence Profile of the Master Thesis

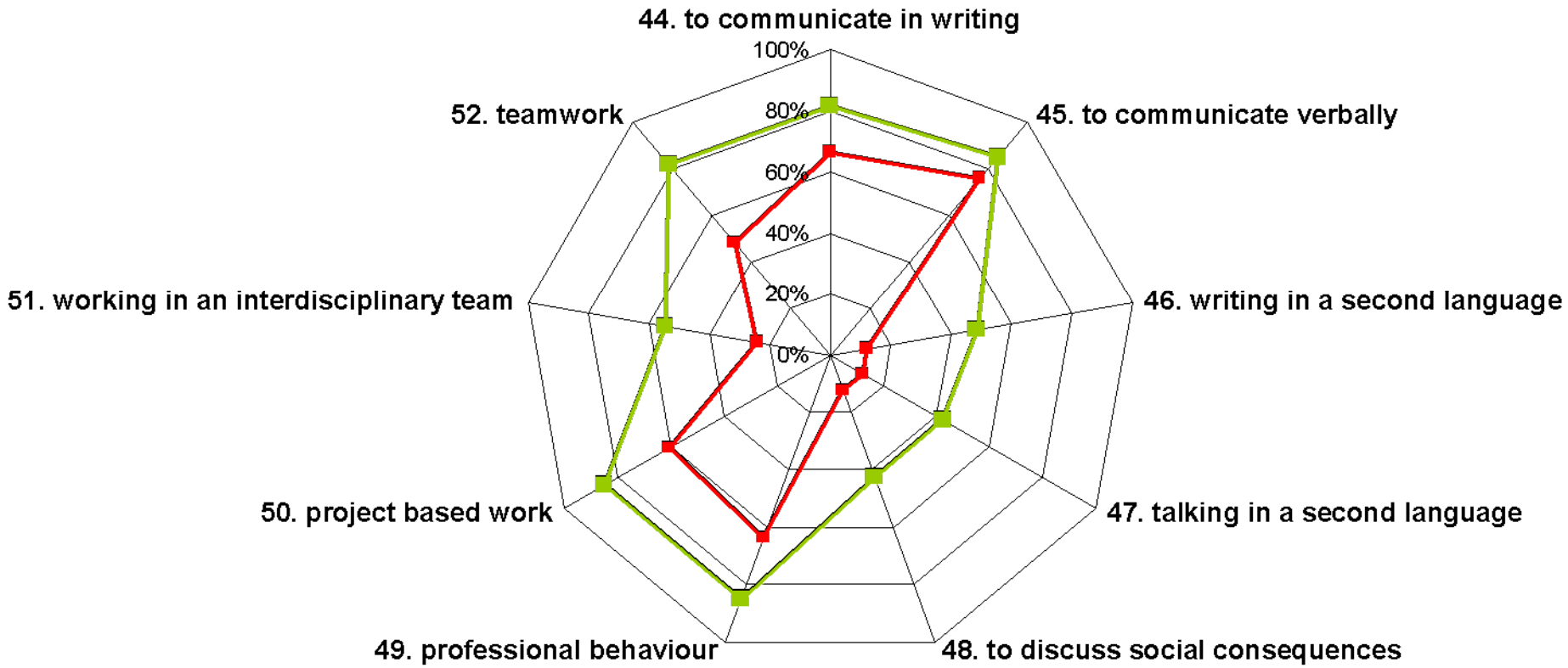
percentage of workload (N=5)



Scientific Discipline – Computer Science, BA
Comparison of Addressed and Assessed Competences
percentage of respondents (N = 37)



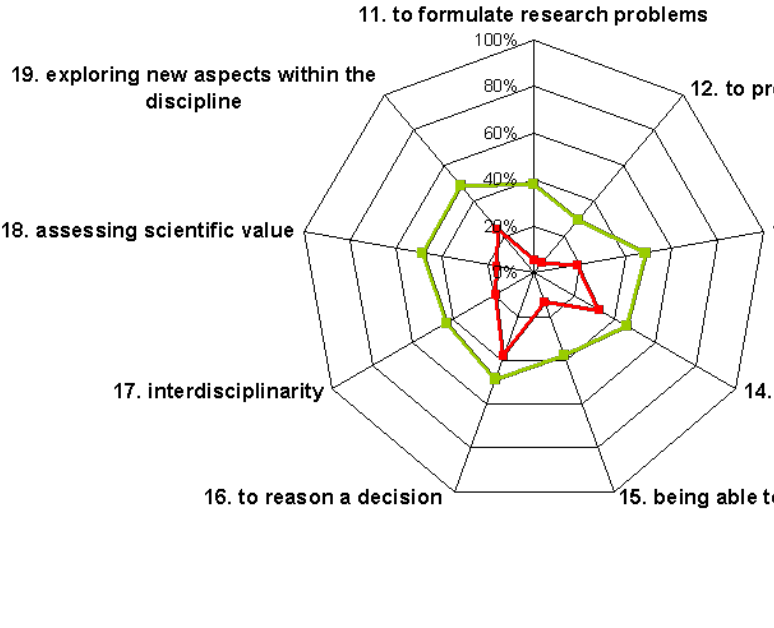
Co-operating and Communicating – Computer Science, MA
Comparison of Addressed and Assessed Competences
percentage of respondents (N = 33)



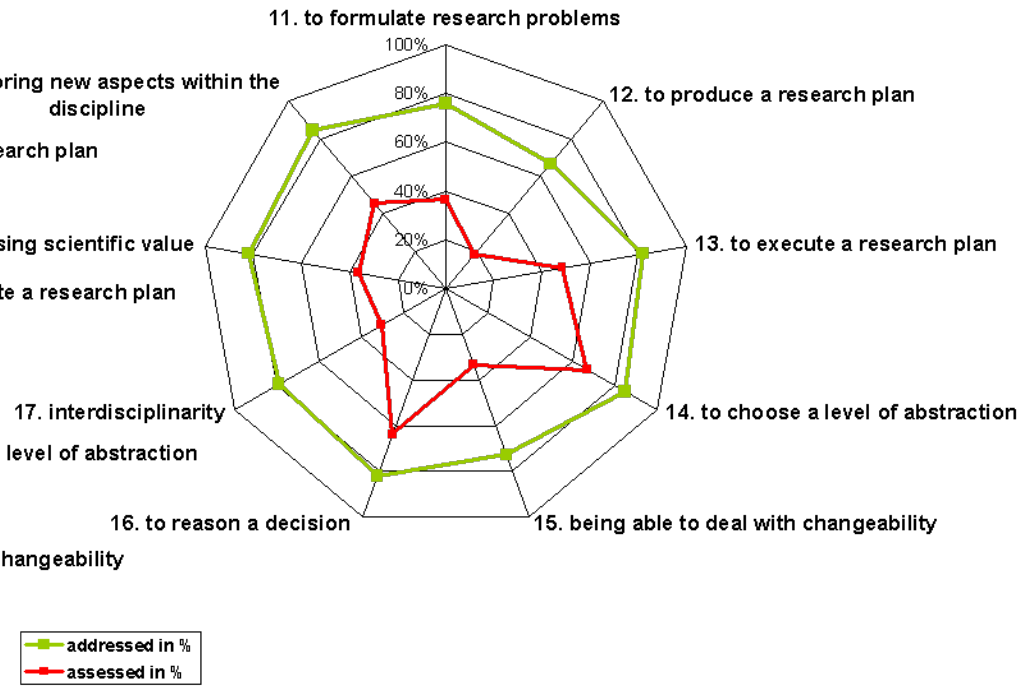
Doing Research – Comparison of MA & BA (Computer Science)

Addressed and Assessed Competences

Bachelor

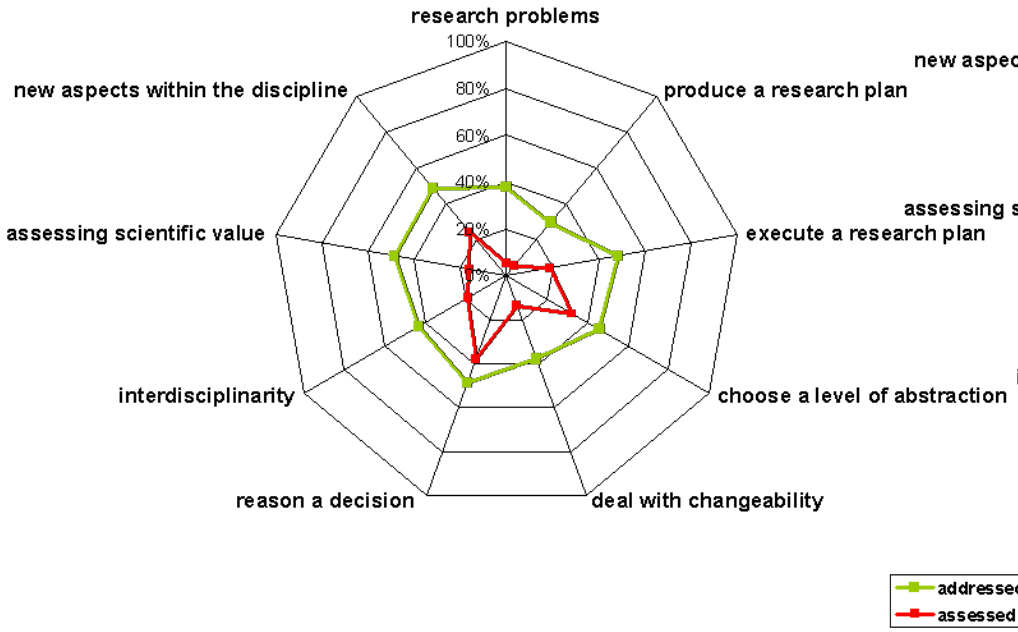


Master

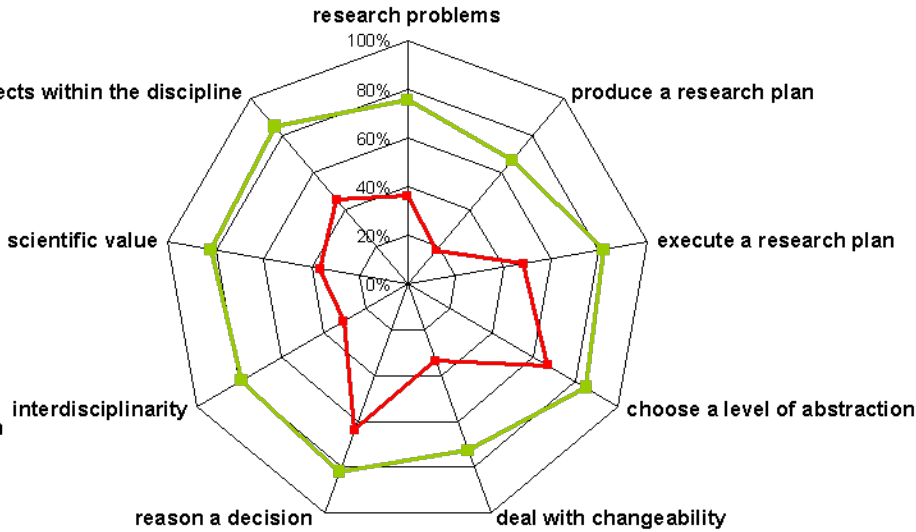


Doing Research – Comparison of MA & BA (Computer Science) Addressed and Assessed Competences

Bachelor

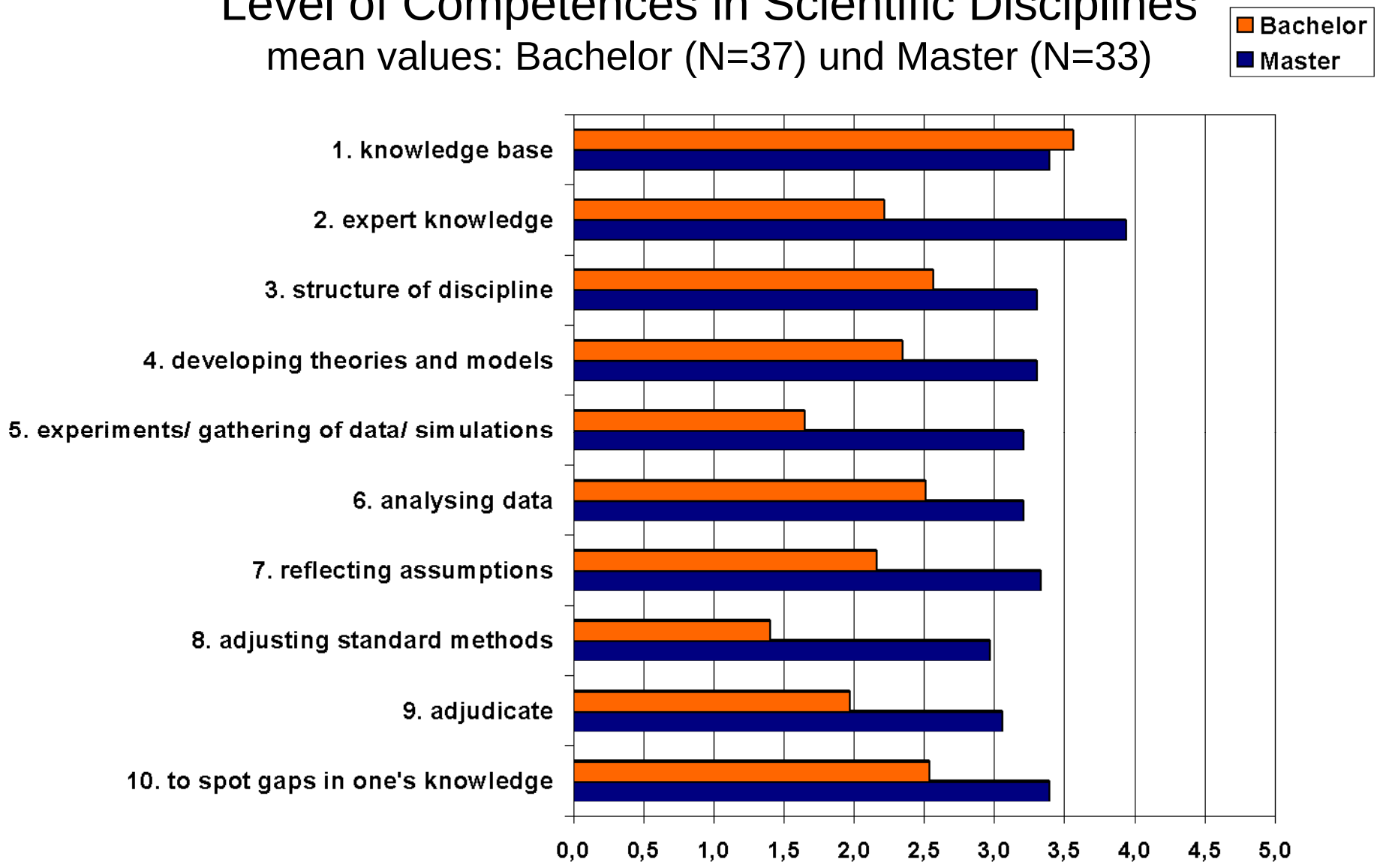


Master



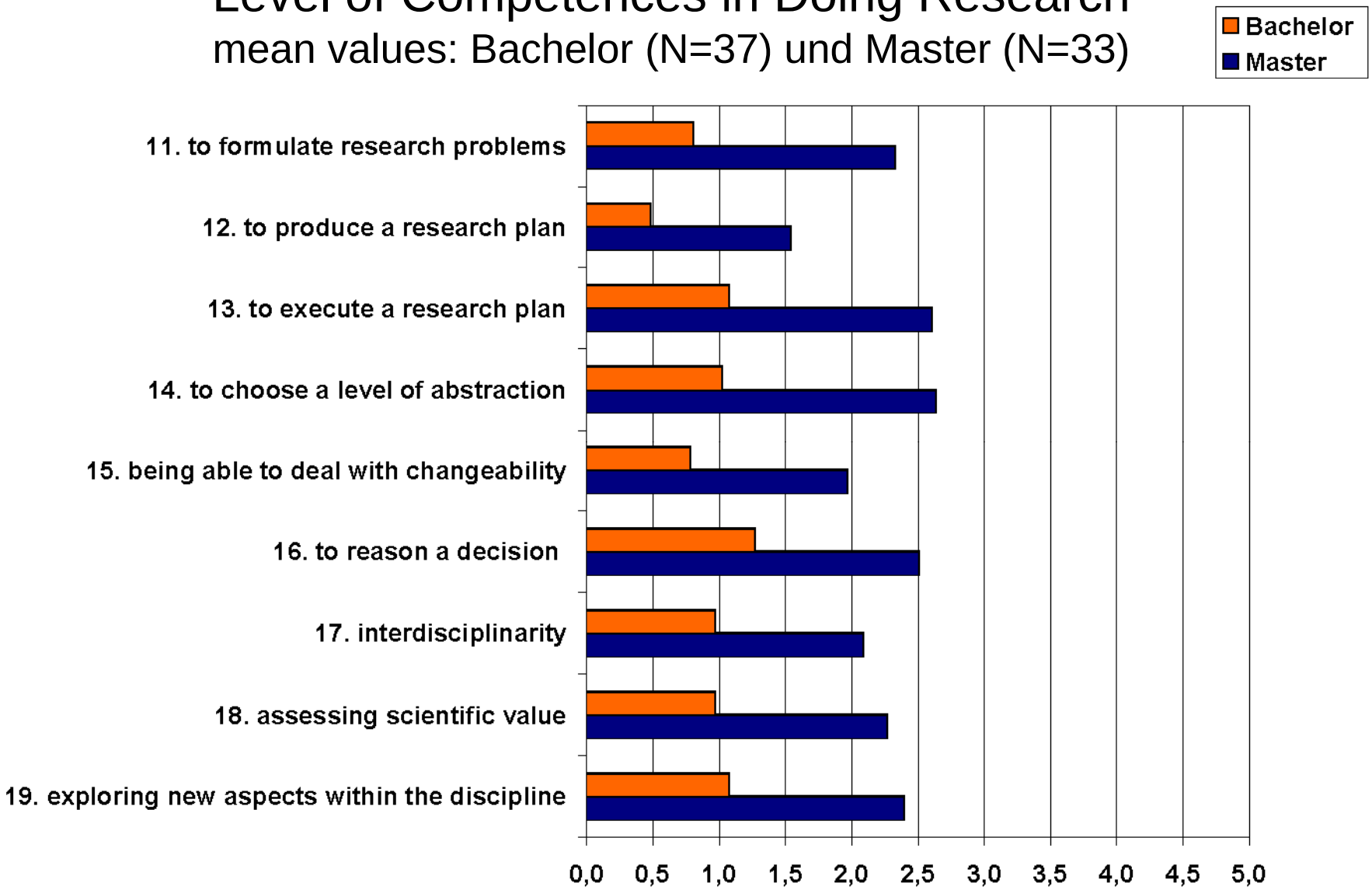
Level of Competences in Scientific Disciplines

mean values: Bachelor (N=37) und Master (N=33)



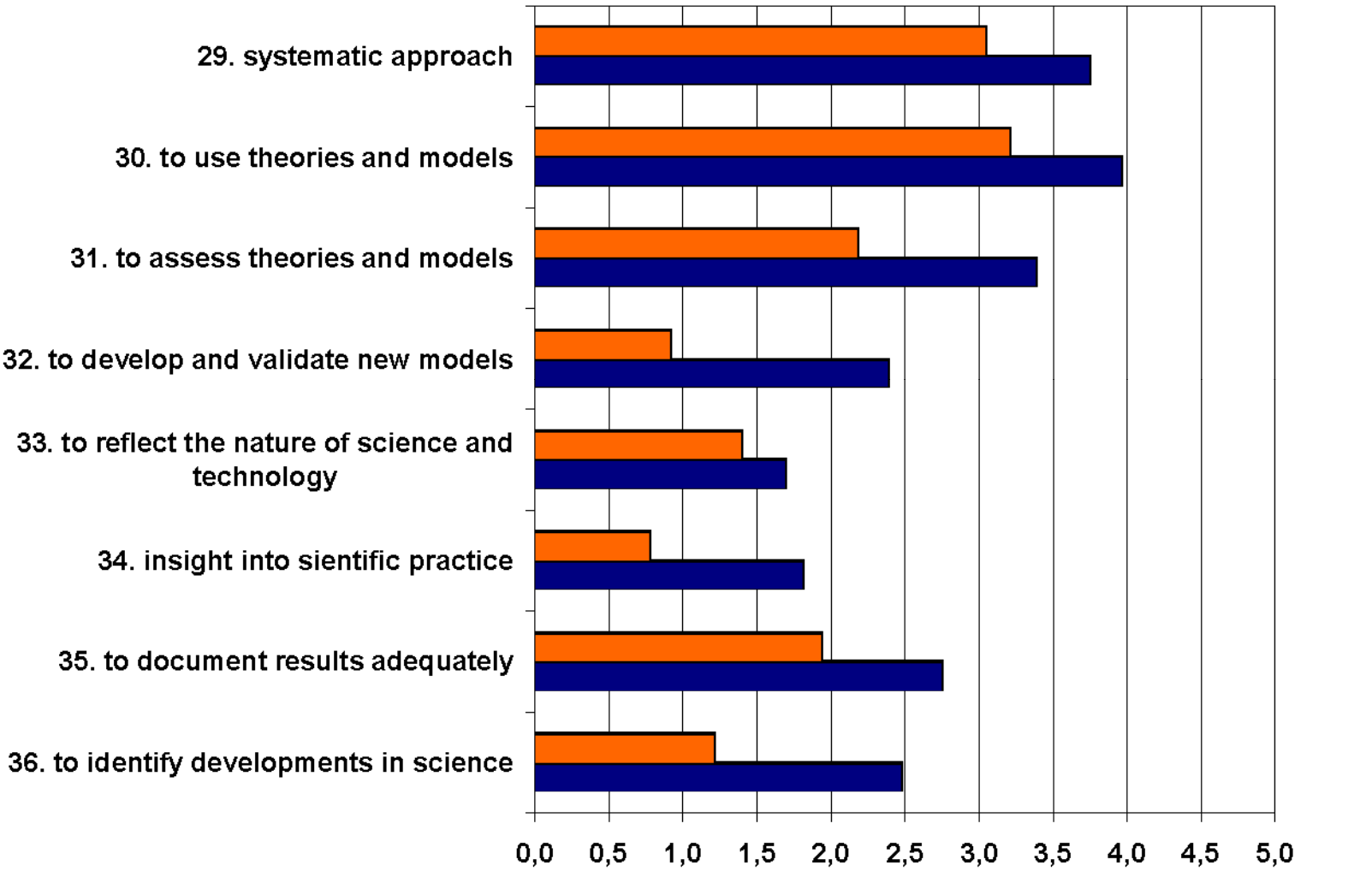
Level of Competences in Doing Research

mean values: Bachelor (N=37) und Master (N=33)



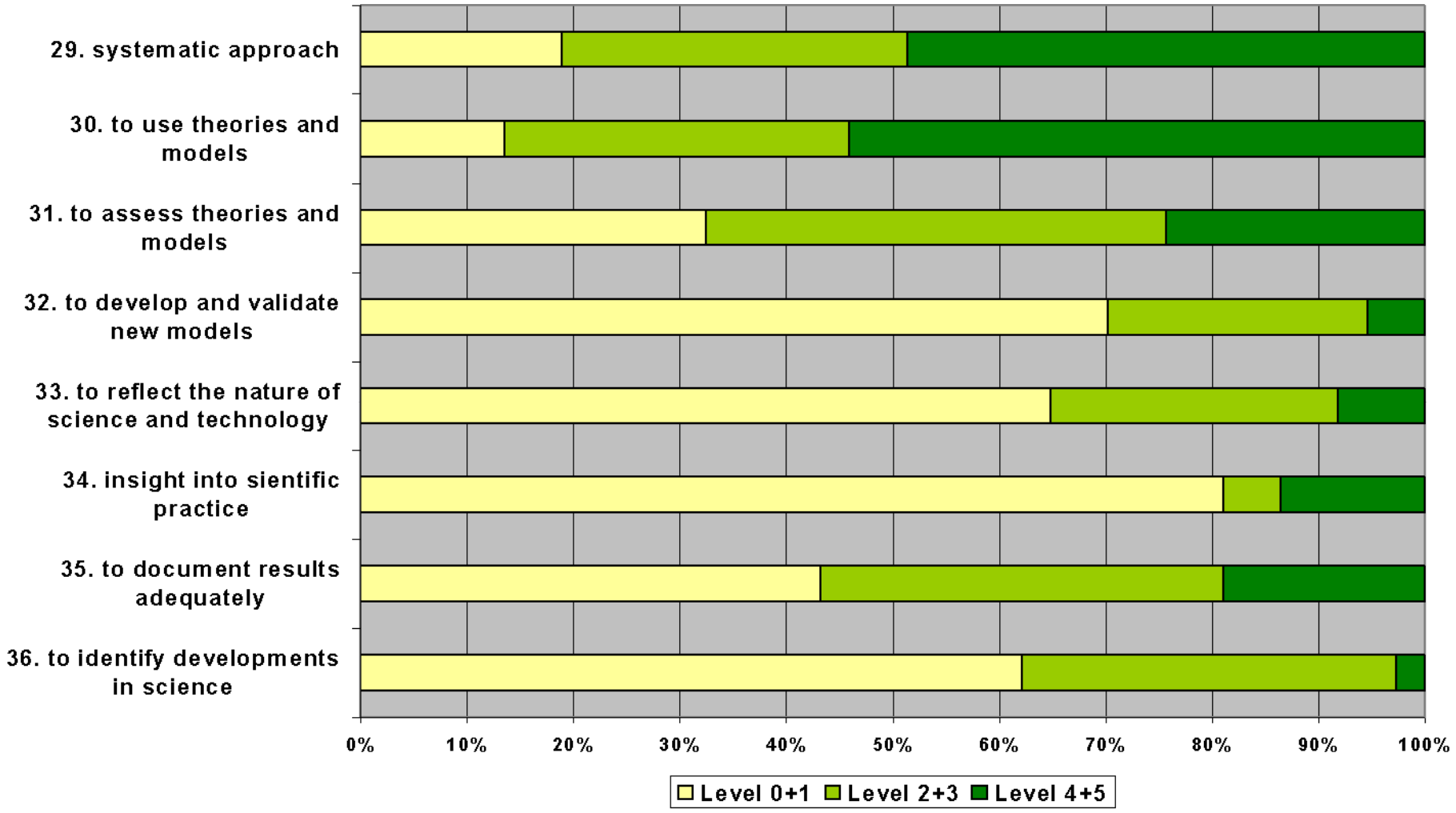
Level of Competences in Scientific Approach

mean values: Bachelor (N = 37) und Master (N = 33)



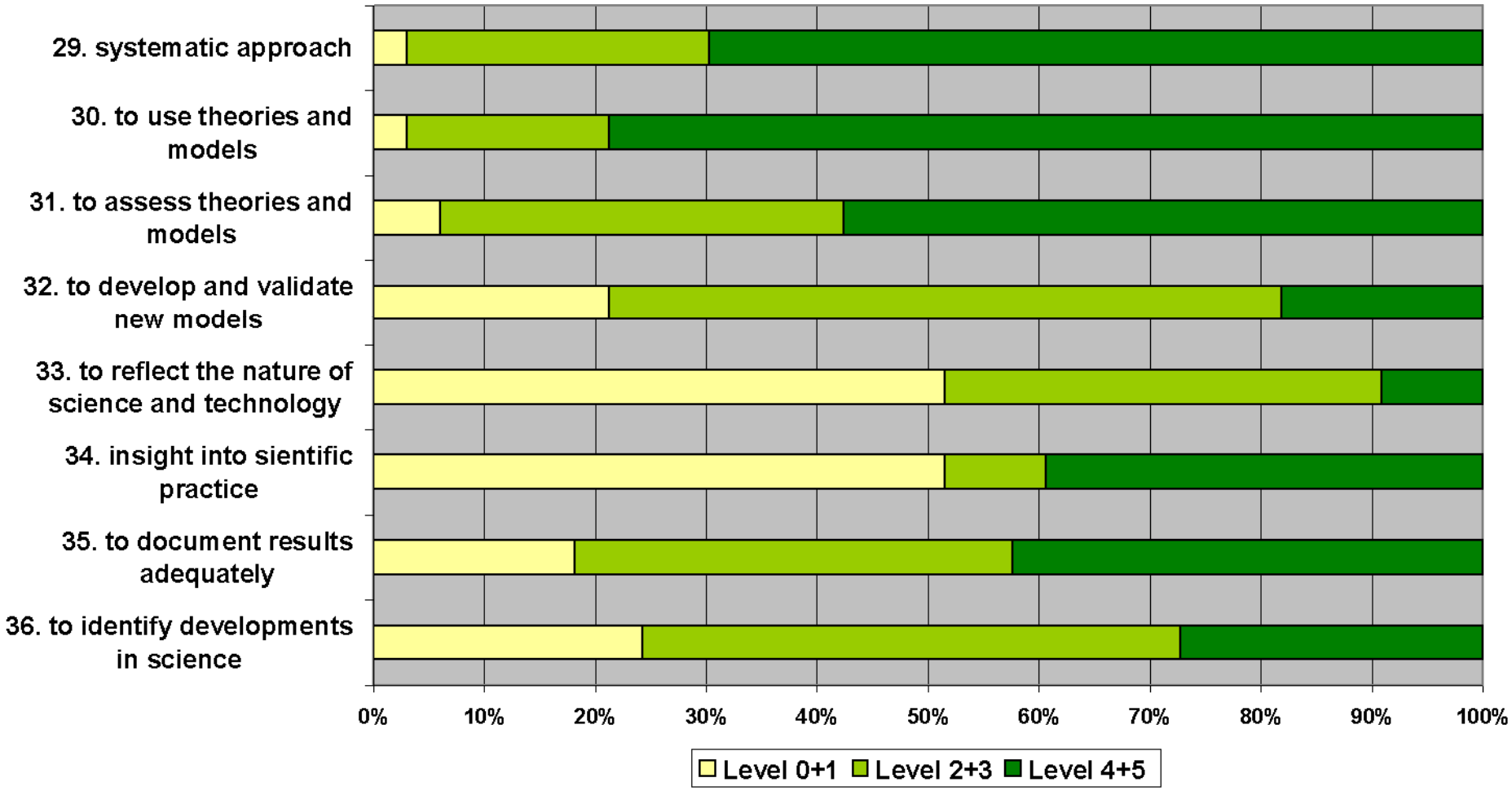
Scientific Approach - Computer Science, BA

distribution of levels (N=37)



Scientific Approach - Computer Science, MA

distribution of levels (N=33)



Cost

- Royalties/fees to the developers of the method (including training)
- 4-5 person-months for the first study program
- 2 person-months for additional programs
- Teachers spend 1 hour per teaching module to answer questions / fill in questionaire

Conclusion

- Helps to force lecturers to (re)consider target competences and how to achieve them
- Helps to check the matching of input and output competences for module sequences
- Helps program manager to identify strengths and weaknesses in program‘s profile
- Gives some evidence for program‘s outcome qualifications by breaking them down to module‘s outcome qualifications

Caveat:

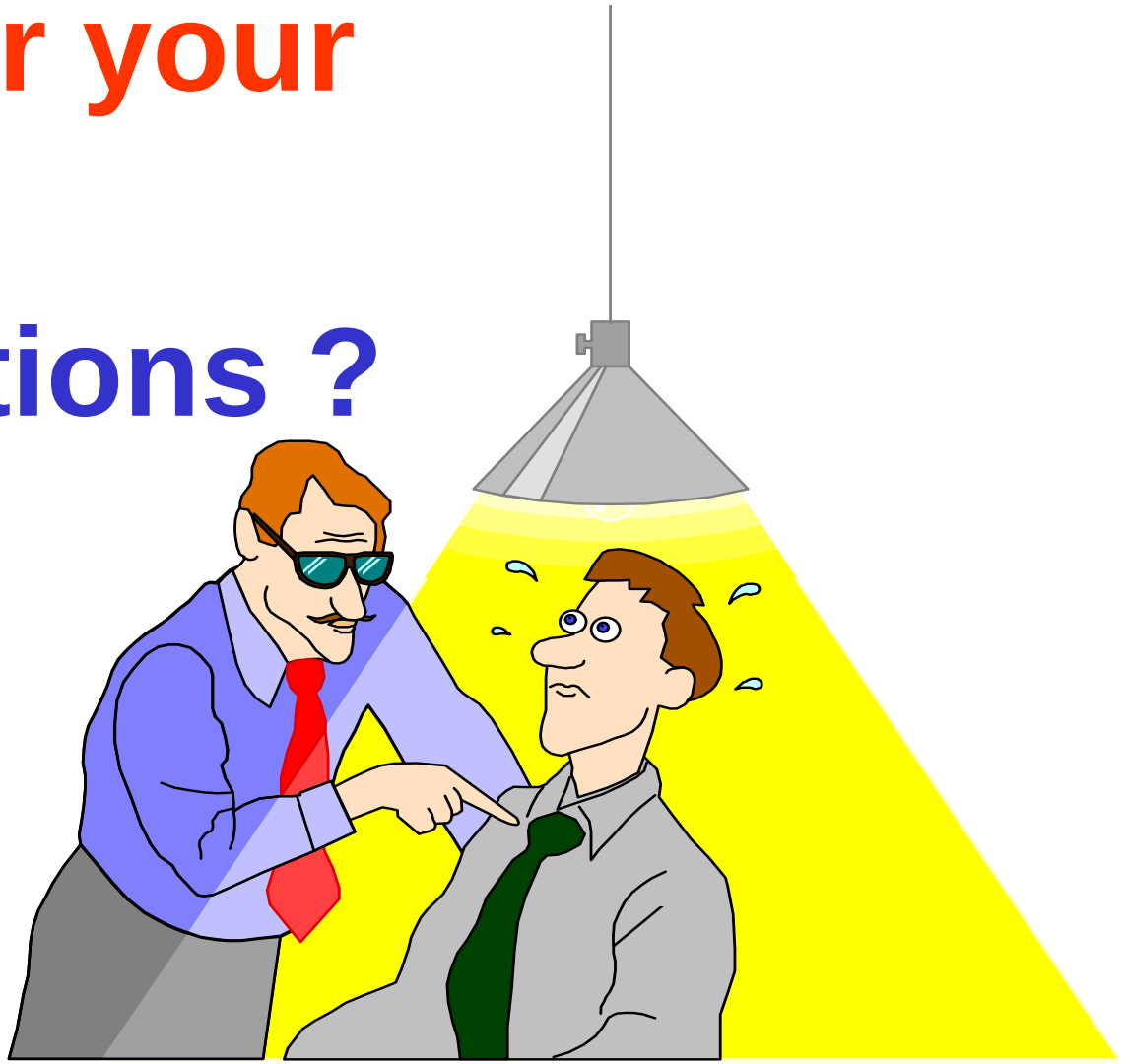
- Based solely on teachers‘ intentions

Further steps

- Interview students about perceived acquisition of competences (module level)
- Interview alumni about perceived acquisition of competences (program level)
- Interview employers about perceived competences of alumni
- Compare, conclude and react

Thanks for your attention.

Any questions ?



40