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**Pedagogical Content Knowledge  
for Computer Science  
in German Teacher Education Curricula**

 WIPSCe 2013, Aarhus, DK, 13. 11.13



Thank you very much for your attention!

**Any questions?**

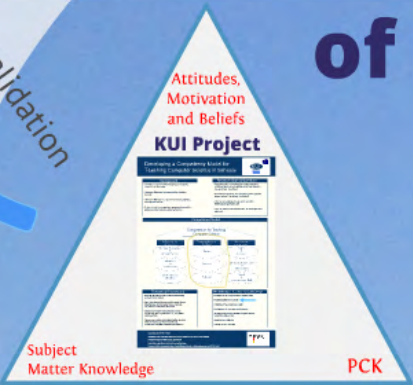
Peter Hubwieser, Marc Berges, Johannes Magenheimer, Niclas Schaper,  
Kathrin Bröker, Melanie Margaritis, Sigrid Schubert, Laura Ohrndorf

# **Pedagogical Content Knowledge for Computer Science in German Teacher Education Curricula**



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# Conceptualization of PCK



**Methodology**

1. Content analysis of German curricula for computer science teacher education
2. Expert interviews according to the Critical Incident Technique
3. Design of competency models and
4. Development of measuring instruments

**Category System**  
 Derivation

inductively      OR      deductively?

The different CS of codon have to be examined      CS has to be derived in advance

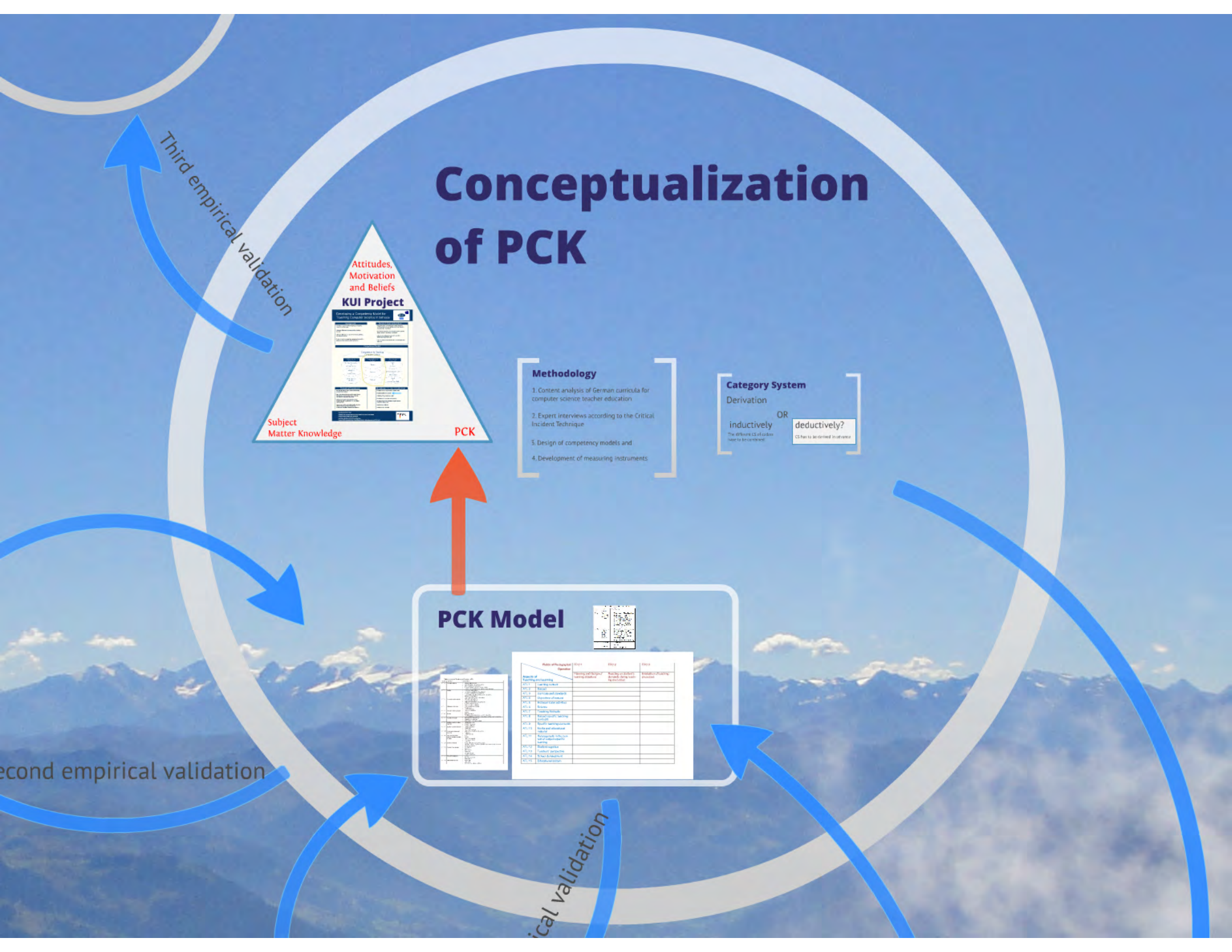
**PCK Model**

	PCK	PCK	PCK
	Content and Pedagogical Learning Material	Didactic Design and Instruction	Didactic Design and Instruction
1. Content analysis of German curricula for computer science teacher education			
2. Expert interviews according to the Critical Incident Technique			
3. Design of competency models and			
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19. Design of competency models and			
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Third empirical validation

Second empirical validation

Critical validation



Validation

of P

# Attitudes, Motivation and Beliefs

## KUI Project

Developing a Competency Model for Teaching Computer Science in Schools



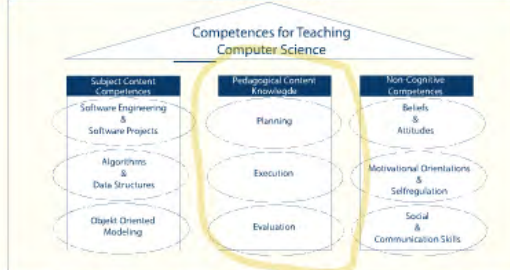
### Background

- Teaching Computer Science in German secondary schools is not consistent
- There are differences between existing teaching concepts
- There are difficulties to transfer the existing teaching concepts into classes
- It does not exist a competence framework or model to guide Computer Science teacher education

### Research Goals & Questions

- The main goal is to examine the competence facets which are necessary for teaching computer science at the secondary school level
- By which competencies are computer science teachers characterized at secondary school level?
- How can an adequate competence model be differentiated and validated?
- How can measurement instruments be developed and validated?

### Competence Model



### Theoretical Framework

- The basic dimensions of the model are theoretically and empirically derived
- Normative oriented assessments of Computer Science Education (e.g. ACM Computer Science Curricula, 2013) serve as an important framework
- Competence models and empirical research on teacher education (e.g. Blömeke et al., 2016) build a solid foundation
- Competence models and empirical studies of related fields of research (e.g. teacher education in mathematics and physics) build relevant references

### Methodological Approach & Study Design

- Development of a competence framework model
- Empirical requirements analysis
- Validation of the competence model
- Development of a measurement instrument
- Assessing competence of future Computer Science teachers in a large sample
- Model and test validation
- Critical recommendations

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 University of Passau: Prof. Heidi Schupp, Prof. Johannes Wimmer, Dr. Sandra Mönig-Wagner  
 University of Siegen: Prof. Sigrid Schwan, Luise Orndorf  
 Technical University of Munich: Prof. Peter Heubrock, Marc Siegel  
 The research initiative is funded by the German Federal Ministry of Education and Research under grant no. 01P11014AC.



Subject  
Matter Knowledge

PCK

# Developing a Competency Model for Teaching Computer Science in Schools



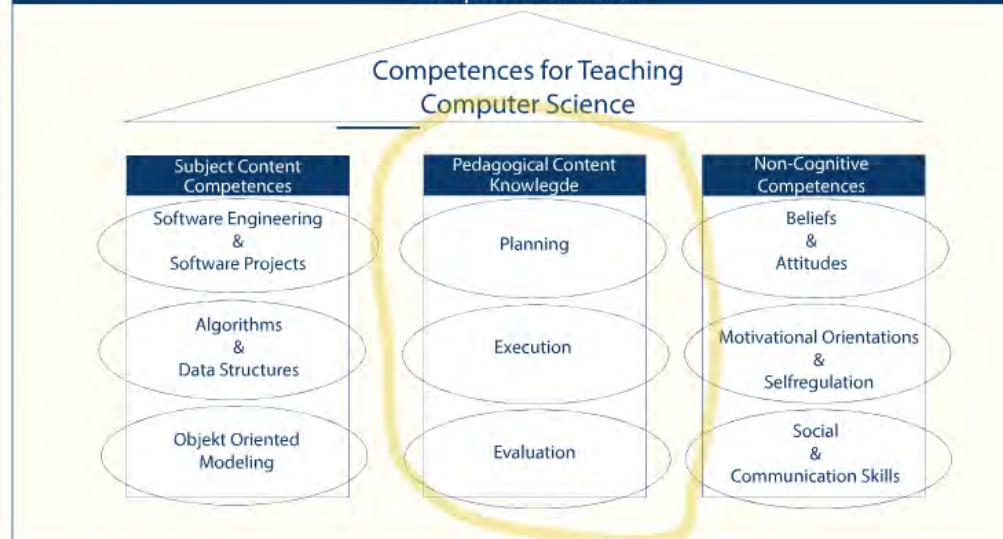
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## Methodological Approach & Study Design

- Development of a competence framework model
- Empirical requirements analysis ←
- Validation of the competence model
- Development of a measurement instrument
- Measuring competences of future Computer Science teachers in a large sample
- Model and test validation
- Curricula recommendation

Sponsorship period: 07/2012 - 06/2015

University of Paderborn: Prof. Nicolas Schaper, Prof. Johannes Magenholm, Elena Bender, Melanie Marguttis

University of Siegen: Prof. Sigrid Schubert, Larus Ohmndorf

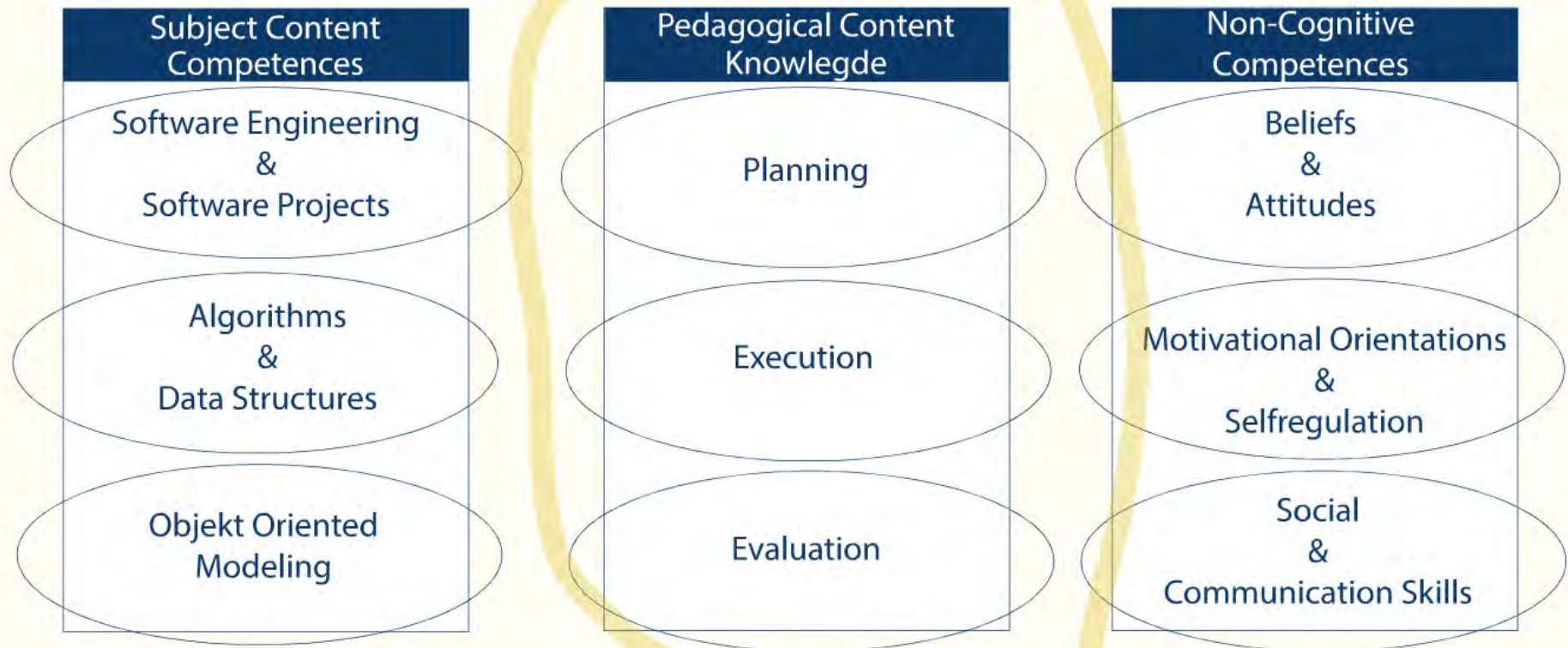
Technical University of Munich: Prof. Peter Hubwieser, Marc Berges

The research initiative is funded by the German Federal Ministry of Education and Research under grant no. 01PK11019A/C



# Competence Model

## Competences for Teaching Computer Science



### Theoretical Framework

The basic dimensions of the model are theoretically and normatively derived

### Methodological Approach & Study Design

- Development of a competence framework model
- Empirical requirements analysis



# Methodology

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# Category System

Derivation

OR

inductively

The different CS of coders  
have to be combined

deductively?

CS has to be derived in advance



# Literature Review

Standards for Teacher Education

Math

Specific models

Biology

Conceptualizations of PCK

Computer  
Science

Textbooks for teacher education

Standards for  
teacher education

## Expert discussion

2 days with Johannes Magenheim  
Sorting, consolidating and  
explaining categories

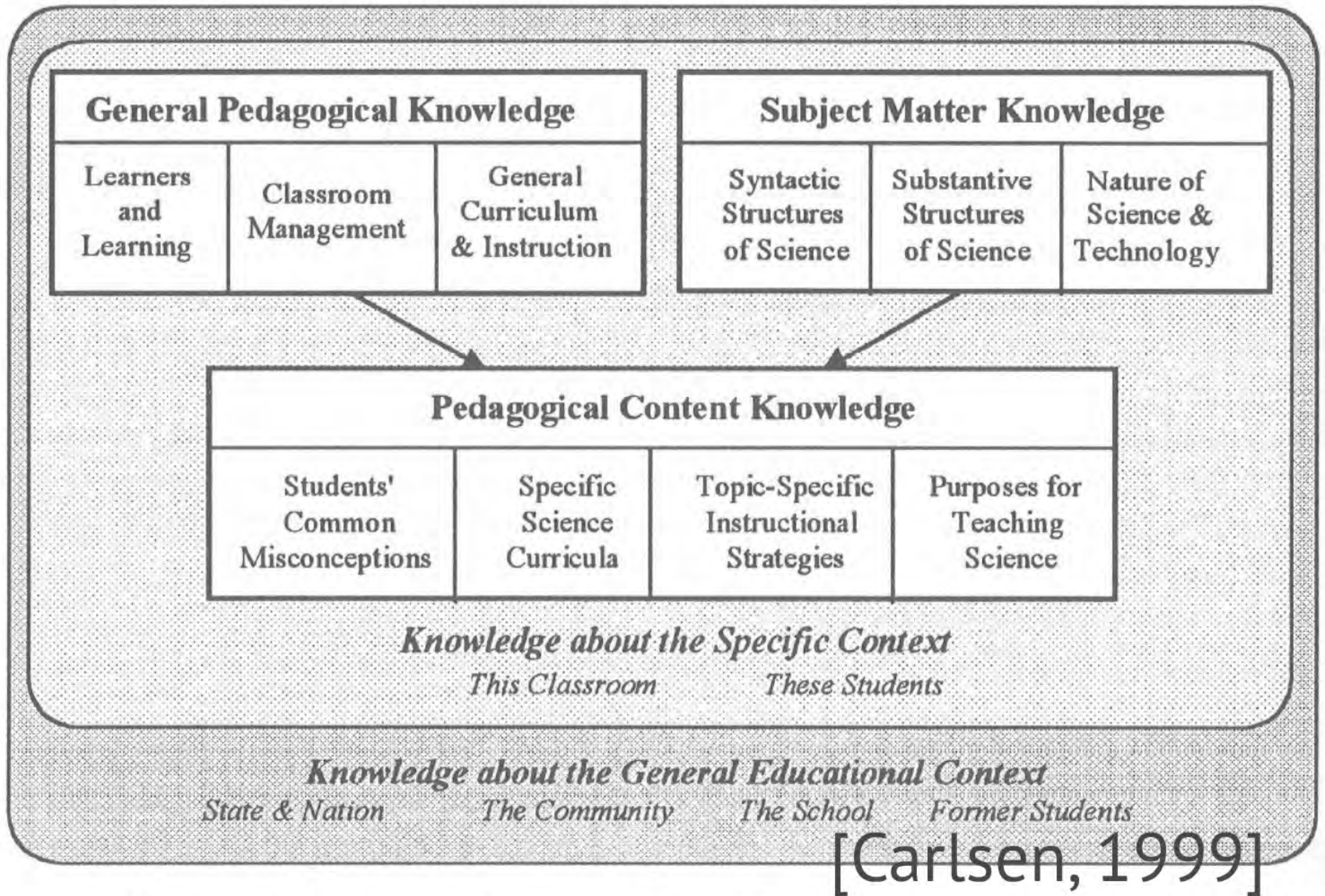
Physics

English  
Language

General definitions of PCK

[Shulman 1986, 1987]





**Figure 1: Carlsen's domains of teacher knowledge [6]**



# **Expert discussion**

2 days with Johannes Magenheim  
Sorting, consolidating and  
explaining categories

# PCK Model

**Table 2.1. Lists of Pedagogical Operation (PO)**

Code	Field of operation	Sub-operations
FPO 1	Planning and design of learning situations	<ul style="list-style-type: none"> <li>Time planning (time allocation)</li> <li>Characterization of the starting situation (starting situation, resources, resources in the approach, pre-conditions for summation)</li> <li>Goals/aims: long-term lesson planning, planning the unit or lesson, planning a lesson</li> </ul>
FPO 2	Reacting on student's demands during teaching processes	<ul style="list-style-type: none"> <li>Activate basic or contextual knowledge as contextual advances, regarding to students' requirements, providing feedback</li> <li>Managing complexity</li> <li>Support completion with planning</li> </ul>
FPO 3	Evaluation of teaching processes	<ul style="list-style-type: none"> <li>Reflections</li> <li>Analysis</li> <li>Formal categories</li> </ul>

**Table 3. Aspects of Teaching and Learning (ATL)**

Gr. No.	Category	Subcategory
ATL 1	Learning content	<ul style="list-style-type: none"> <li>Multiple representation</li> <li>Category systems for learning content</li> <li>Specific school-related content</li> <li>Structure and organization of learning content</li> <li>Didactical (re-) construction of subject-related knowledge</li> </ul>
ATL 2	Subject	<ul style="list-style-type: none"> <li>Relation to other subjects</li> <li>Definition of computer science education</li> <li>History of computer science education</li> <li>Relevance of the subject to the scientific discipline</li> <li>Objectives of the subject</li> <li>Legitimacy and relevance of the subject</li> </ul>
ATL 3	Curricula and standards	<ul style="list-style-type: none"> <li>Curriculum development</li> <li>Relation to other subjects</li> <li>Approach and structure of the curriculum</li> <li>Structural and content-related aspects</li> <li>Actual examples of curricula</li> </ul>
ATL 4	Objectives of lessons	<ul style="list-style-type: none"> <li>Focus on education standards</li> <li>Competencies</li> <li>Learning objectives</li> </ul>
ATL 5	Extracurricular activities	<ul style="list-style-type: none"> <li>Interest cultivation</li> <li>Games</li> </ul>
ATL 6	Science	<ul style="list-style-type: none"> <li>Subject discipline</li> <li>Computer science education as a scientific discipline</li> <li>Relationship between teaching of the subject and the scientific discipline</li> </ul>
ATL 7	Teaching Methods	<ul style="list-style-type: none"> <li>Didactical strategies</li> <li>Methodological principles</li> <li>Subject-specific teaching methods</li> </ul>
ATL 8	Subject-specific teaching concepts	<ul style="list-style-type: none"> <li>Introductory lesson</li> <li>Programming class</li> <li>Historical approach</li> <li>Lab-based teaching</li> <li>Experiments</li> <li>Tasks and assignments</li> </ul>
ATL 9	Specific teaching elements	<ul style="list-style-type: none"> <li>Application of hardware and software</li> <li>Toolbooks</li> <li>Employment of media</li> </ul>
ATL 10	Media and educational material	<ul style="list-style-type: none"> <li>Age</li> <li>Gender</li> <li>Ethnic background</li> <li>Family socialization</li> <li>Proficiency</li> </ul>
ATL 11	Heterogeneity in the context of subject-specific learning	<ul style="list-style-type: none"> <li>General subject-related cognitive aspects</li> <li>Individual learning: diagnostics, performance evaluation and assessment</li> <li>Cognitive activities</li> <li>Collaboration</li> <li>Contexts</li> <li>Qualification</li> <li>Motivation</li> <li>In-service training</li> <li>Teacher competence</li> <li>Persons</li> <li>Quality management</li> <li>School profile</li> </ul>
ATL 12	Student cognition	<ul style="list-style-type: none"> <li>School type</li> <li>Environment</li> <li>Orientation-related aspects of subject</li> </ul>
ATL 13	Teachers' perspective	
ATL 14	School development	
ATL 15	Educational system	

Fields of Pedagogical Operation		FPO 1	FPO 2	FPO 3
		Planning and design of learning situations	Reacting on student's demands during teaching processes	Evaluation of teaching processes
Aspects of Teaching and Learning	ATL 1	Learning content		
	ATL 2	Subject		
	ATL 3	Curricula and standards		
	ATL 4	Objectives of lessons		
	ATL 5	Extracurricular activities		
	ATL 6	Science		
	ATL 7	Teaching Methods		
	ATL 8	Subject-specific teaching concepts		
	ATL 9	Specific teaching elements		
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ATL 15	Educational system			

**Table 2. Fields of Pedagogical Operation (FPO)**

<i>Cat. No.</i>	<i>Field descriptor</i>	<i>Subcategories</i>
FPO 1	Planning and design of learning situations	<ul style="list-style-type: none"><li>- Time planning (Time allocation),</li><li>- Explanation of the planning: subject specific consistency, reasonability of the approach, psychological argumentation</li><li>- Granularity: long term lesson planning, planning the entire curriculum, planning a lesson</li></ul>
FPO 2	Reacting on student's demands during teaching processes	<ul style="list-style-type: none"><li>- Reacting based on understanding: flexible use of connected knowledge in critical situations, responding to students appropriately, responding flexibly</li><li>- Mastering complexity</li><li>- Keeping compliant with planning</li></ul>
FPO 3	Evaluation of teaching processes	<ul style="list-style-type: none"><li>- Techniques,</li><li>- Criteria</li><li>- Derive consequences</li></ul>

**Table 3. Aspects of Teaching and Learning (ATL)**

<i>Cat. No.</i>	<i>Category</i>	<i>Subcategories</i>
ATL 1	<b>Learning content</b>	<ul style="list-style-type: none"> <li>- Multiple representations</li> <li>- Category systems for learning content</li> <li>- Specific school-related content</li> <li>- Selection and justification of learning content</li> <li>- Didactical (re-) construction of subject-matter knowledge</li> </ul>
ATL 2	<b>Subject</b>	<ul style="list-style-type: none"> <li>- Relations to other subjects</li> <li>- Definition of computer science education</li> <li>- History of computer science education</li> <li>- Relationship of the subject to the scientific discipline</li> <li>- Objectives of the subject</li> <li>- Legitimacy and relevance of the subject</li> </ul>
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ATL 4	<b>Objectives of lessons</b>	<ul style="list-style-type: none"> <li>- Focus on education standards</li> <li>- Competencies</li> <li>- Learning objectives</li> </ul>
ATL 5	<b>Extracurricular activities</b>	<ul style="list-style-type: none"> <li>- External collaboration</li> <li>- Contests</li> </ul>
ATL 6	<b>Science</b>	<ul style="list-style-type: none"> <li>- Subject discipline</li> <li>- Computer science education as a scientific discipline</li> <li>- Relationship between teaching of the subject and the scientific discipline</li> </ul>
ATL 7	<b>Teaching Methods</b>	<ul style="list-style-type: none"> <li>- Organizational arrangements</li> <li>- Methodological principles</li> <li>- Subject-specific teaching methods</li> </ul>
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ATL 9	<b>Specific teaching elements</b>	<ul style="list-style-type: none"> <li>- Lab-based teaching</li> <li>- Experiments</li> <li>- Tasks and assignments</li> </ul>
ATL 10	<b>Media and educational material</b>	<ul style="list-style-type: none"> <li>- Application of hardware and software</li> <li>- Textbooks</li> <li>- Unplugged media</li> </ul>
ATL 11	<b>Heterogeneity in the context of subject-specific learning</b>	<ul style="list-style-type: none"> <li>- Age</li> <li>- Gender</li> <li>- Ethnical background</li> <li>- Family socialization</li> <li>- Disabilities</li> </ul>
ATL 12	<b>Student cognition</b>	<ul style="list-style-type: none"> <li>- General subject-related cognitive aspects</li> <li>- Individual learning Diagnostics, performance evaluation and assessment</li> <li>- Cognitive activation</li> </ul>
ATL 13	<b>Teachers' perspective</b>	<ul style="list-style-type: none"> <li>- Collaboration</li> <li>- Core tasks</li> <li>- Qualification</li> <li>- Motivation</li> <li>- In-service training</li> <li>- Teaching experience</li> </ul>
ATL 14	<b>School development</b>	<ul style="list-style-type: none"> <li>- Policies</li> <li>- Quality management</li> <li>- School profile</li> </ul>
ATL 15	<b>Educational system</b>	<ul style="list-style-type: none"> <li>- School type</li> <li>- Enrollment</li> <li>- Organizational aspects of subject</li> </ul>

## Aspects of Teaching and Learning

ATL 1

ATL 2

ATL 3

ATL 4

ATL 5

ATL 6

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		- Historical approach
ATL 9	<b>Specific teaching elements</b>	- Lab-based teaching - Experiments - Tasks and assignments
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ATL 14	<b>School development</b>	- Policies - Quality management - School profile
ATL 15	<b>Educational system</b>	- School type - Enrollment - Organizational aspects of subject

# Teacher Interviews

## Sample

11 guide-line based interviews collected during a large in-service teacher training course in July 2010  
drawing from 150 attending teachers

## Methodology

Introductory open question: "If you consider the preparation of CS lessons, how would you normally proceed, what problems would you face and how would you solve these problems?"

- Stimulation of the following categories:
- preconditions
  - learning objectives
  - learning content
  - teaching methods
  - media, sources of information
  - assignments
  - collaboration with other teachers

## Data gathering

recording on mobile phones  
11 interviews from 20 to 35 minutes  
4 female and 7 male teachers  
transcribed by student workers  
coded inductively by two authors  
applying qualitative content analysis  
combining the 2 category systems in discussion

## Resulting Category System 2010

- 1) Conditions: preconditions, state condition
- 2) Goals
- 3) Approach: example dialog, task planning, programming, writing, editing, writing, script, preparing, scenarios, identifying difficulties, re-organization
- 4) Sources: textbook, content, additional material, internet, teacher training, pedagogical theory, pedagogical literature, pedagogical knowledge, material from own studies, own personal notes
- 5) Collaboration: in school, with other experiments, between schools
- 6) Time planning
- 7) Methods and organizational arrangements: individual, flexible, student activity, presentation, discussion, teaching, non-reflective dialog, one-to-one, group, pair, individual work, group work, differentiation, task by student
- 8) Media: board, blackboard, whiteboard, computer software, overhead projector, whiteboard, whiteboard, overhead projector
- 9) Problems: technical difficulties, too much content, poor, empty, wrong, mistakes, poor-quality knowledge, student support, etc.
- 10) Assessment: written, oral, project, etc. graded
- 11) Evaluation

Table 4. Inventory catalog for the top-level categories

Code	Category	Describe the content
A1.1	preparation	First for an interview with a teacher, we have not chosen to use beyond the range of the course, but the level of detail.
A1.3	the selected sources	Textbook, content, additional material, internet, pedagogical literature, pedagogical literature, pedagogical literature, pedagogical literature, etc.
A1.5	subject-specific teaching	Preparation of material, not prepared by the teacher.
A1.10	Media and organizational arrangements	Methods that involve media, software, teaching methods, group work, individual work, etc.
A1.11	Integration in the professional context	There is no connection to the possibilities for the teacher to integrate the lesson into the curriculum, but there are no specific possibilities to do so.
A1.13	Teacher's personal	Personal notes, pedagogical knowledge, pedagogical literature, etc.
A1.15	technical events	Technical difficulties, too much content, poor, empty, wrong, mistakes, poor-quality knowledge, student support, etc.

## Overall result

Matching the category as shown in all categories of 2010 were covered by the model.

## Matching with our PCK Model 2013

### Overall result

Matching the categories showed that all categories of 2010 were covered by the model.

Table 5. Addressed categories that were not stimulated

Code	Category	Checked (Determined)
ATL 12	Student cognition	11
ATL 9	Special teaching situations	10
ATL 4	Curriculum and standards	9
ATL 8	Subject-specific teaching contents	5
ATL 13	Educational system	4
ATL 5	Subject	1

## **Sample**

11 guide-line based interviews

collected during a large in-service teacher training course in July 2010

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## Methodology

Introductory, open question:

“If you consider the preparation of CS lessons, how would you normally proceed, which problems would you face and how would you solve these problems?”

Stimulation of the following categories:

- preconditions
- learning objectives
- learning content
- teaching methods
- media, sources of information
- assignments
- collaboration with other teachers.

## Resulting Category System 2010

- 1) **Conditions:** preconditions, frame conditions
- 2) **Goals**
- 3) **Approach:** example driven, time planning, programming, writing outline, writing script, planning homework, identifying difficulties, by own mistakes
- 4) **Sources:** textbook, curriculum, additional material, internet, teacher training, books/journals from subject-matter , colleagues, existing knowledge, material from own studies, pre-planned lessons
- 5) **Collaboration:** in school, with other departments, between schools
- 6) **Time planning**
- 7) **Methods and organizational arrangements:** individual learning, student activity, presentation, classroom teaching, teacher-class dialog, worksheet, entry in exercise book, project work, file, repetition, group work, differentiation, talk by students
- 8) **Media:** beamer, blackboard, moodle, computer, software, overhead projection, textbook, whiteboard, illustrations
- 9) **Problems:** technical difficulties, too much content, room, ensuring learning, standards, pre-requisite knowledge, official support, class size
- 10) **Assessment:** written, oral, project, not graded
- 11) **Evaluation.**

### Overall Result

Matching the categories showed that all categories of 2010 were covered by the model

**Table 4. Exemplary codings for the top level categories**

<i>Cat. No.</i>	<i>Category</i>	<i>Quotes from the interviews</i>
ATL 1	Learning content	I look for an important goal as a headline for the lesson and afterwards for a few keywords that have to be covered, that I have to discuss
ATL 3	Curricula and standards	Then I look at the sub-topics of the curriculum, how far that fits. If it fits, I put away the curriculum because I don't need it any more.
ATL 8	Subject-specific teaching concepts	I program that for myself, and then I prepare the teaching from it.
ATL 10	Media and educational material	Finally I then look in the textbook, which things, which tasks might fit here, I look at the introduction of the book, do I like it or don't I.
ATL 11	Heterogeneity in the professional context	I must take into account the preconditions that the students have. Because of course someone who has less prerequisite knowledge and has not yet understood certain things is not able to do the job in the same way than anybody else.
ATL 13	Teacher's perspective	I cooperate with a colleague, thank goodness, which is probably rather rare because there are hardly any schools that have two people who master this subject.
ATL 15	Educational system	So I have two subsequent hours for each lesson in all cases.

## Matching with our PCK Model 2013

### Overall Result

Matching the categories showed that all categories of 2010 were covered by the model

**Table 5. Addressed categories that were not stimulated**

<i>Cat. No.</i>	<i>Category</i>	<i>Coded interviews</i>
ATL 12	Student cognition	11
ATL 9	Specific teaching elements	10
ATL 3	Curricula and standards	9
ATL 8	Subject-specific teaching concepts	5
ATL 15	Educational system	4
ATL 2	Subject	1

## Overall Result

Matching the categories showed that all categories of 2010 were covered by the model



# Coding of Curricula

## Sample

45 teacher education curricula from the websites of German universities  
 Module descriptions, courses of subject-matter didactics  
 5 did not comprise such course  
 38 were analysed  
 deductive content analysis

## Coding Process

4 coding persons  
 most curricula were coded by 1 person  
 22 curricula (50%) by 2 persons  
 calculating inter-coder-reliability was critical  
 - process was often time-consuming  
 - coding guidelines left room for different interpretations  
 - number of categories was often too high

## Overall Result

Matching the categories showed that all found categories were covered by our PCK model.

Table 4: Curricula with more than 12 coded categories

GV = Gymnasium (General School, Academic High School), RS = Realschule (Middle School), WS = Wirtschaftswissenschaftliche (Commercial Science School), LS = Oberschule (Main School), GS = Gesamtschule (Integrated School)

University	School Types	PCK Categories	PCK Coverage
Universität Siegen	GV, RS	15	83%
Pädagogische Hochschule Weingarten	WS, RS, LS	15	83%
Technische Universität Kaiserslautern	GV, RS	14	78%
Universität Paderborn	GV, GS	14	78%
Universität Saarbrücken	GV	14	78%
Pädagogische Hochschule Karlsruhe	WS, RS, LS	14	78%
Pädagogische Hochschule Schwäbisch Gmünd	WS, RS, HS	13	72%

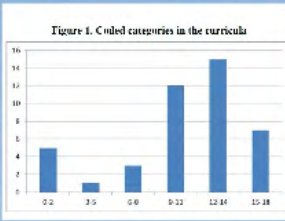


Table 5: Coding Frequency of EPO categories

Code	Category	Coding Frequency
EPO1	Planning and design of learning situations	71%
EPO3	Evaluation of teaching processes	50%
EPO2	Reacting to students demands during teaching processes	21%

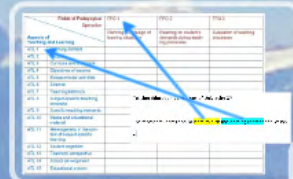
Table 6: Coding Frequency of ATL categories

No.	Category	Coding Frequency
ATL 1	Learning content	89%
ATL 3	Curricula and standards	82%
ATL 6	Science	82%
ATL 2	School subject	76%
ATL 8	Subject-specific teaching concepts	66%
ATL 7	Teaching Methods	66%
ATL 4	Organization of lessons	66%
ATL 10	Media and educational material	61%
ATL 12	Student cognition	61%
ATL 13	Teachers' perspective	55%
ATL 9	Specific teaching elements	39%
ATL 11	Heterogeneity in the context of subject-specific learning	37%
ATL 15	Educational system	34%
ATL 5	Interdisciplinary activities	34%
ATL 14	School development	32%

Table 7: Coding Frequency of Cognitive Processes

Code	Category	Coding Frequency
CPD 3	Apply	83%
CPD 5	Evaluate	79%
CPD 4	Analyze	74%
CPD 2	Understand	68%
CPD 6	Create	63%
CPD 1	Remember	60%

## Cross Codings



Second

# Sample

43 teacher education curricula  
from the websites of German universities

Module descriptions  
courses of subject-matter didactics

5 did not comprise such course  
38 were analysed

deductive content analysis

# Coding Process

4 coding persons

most curricula were coded by 1 person

12 curricula (>30%) by 2 persons

calculating intercoder-reliability was critical

- granularity was different (although agreed before)
- existing coefficients not applicable (Cohen's and Brennan & Prediger's Kappa, Krippendorff's Alpha)

## Overall Result

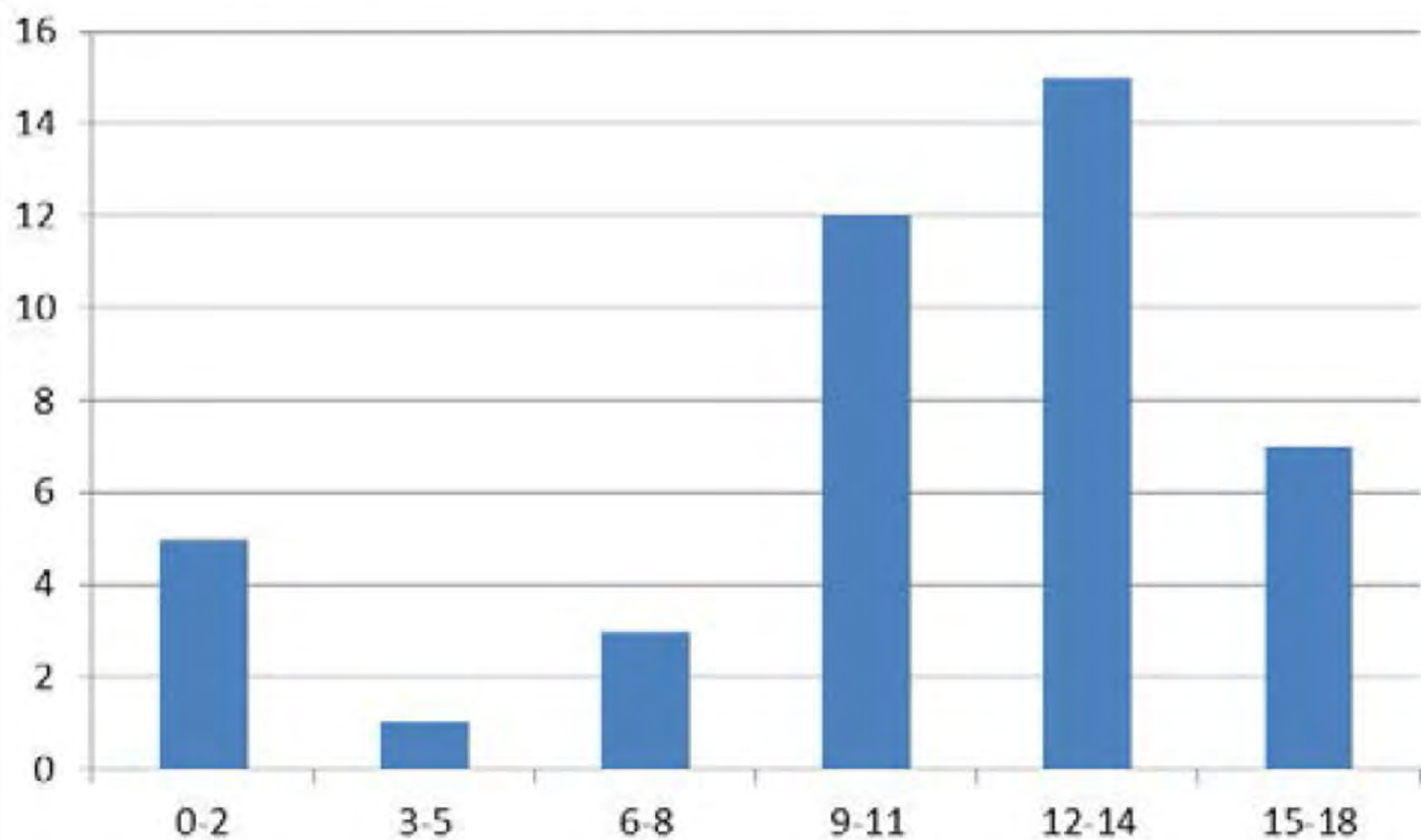
Matching the categories showed that all found categories were covered by our PCK model

**Table 4. Curricula with more than 12 coded categories**

GY = Gymnasium (Grammar School, Academic High School), RS = Realschule (Middle School), WRS = Wirtschaftsrealschule (Commercial Middle School), HS = Hauptschule (Main School), GS = Gesamtschule (Integrated School)

<i>University</i>	<i>School Types</i>	<i>PCK Categories</i>	<i>PCK Coverage</i>
Universität Siegen	GY, HS, RS	15	83%
Pädagogische Hochschule Weingarten	WRS, RS, HS	15	83%
Technische Universität Kaiserslautern	GY, RS	14	78%
Universität Paderborn	GY, GS	14	78%
Universität Saarbrücken	GY	14	78%
Pädagogische Hochschule Karlsruhe	WRS, RS, HS	14	78%
Pädagogische Hochschule Schwäbisch Gmünd	WRS, RS, HS	13	72%

**Figure 1. Coded categories in the curricula**



**Table 5. Coding Frequency of FPO categories**

<i>Code</i>	<i>Category</i>	<i>Coding Frequency</i>
FPO 1	Planning and design of learning situations	71%
FPO 3	Evaluation of teaching processes	50%
FPO 2	Reacting on students demands during teaching processes	21%

**Table 6: Coding Frequency of ATL categories**

<i>No.</i>	<i>Category</i>	<i>Coding Frequency</i>
ATL 1	Learning content	89%
ATL 3	Curricula and standards	82%
ATL 6	Science	82%
ATL 2	School subject	76%
ATL 8	Subject-specific teaching concepts	66%
ATL 7	Teaching Methods	66%
ATL 4	Objectives of lessons	66%
ATL 10	Media and educational material	61%
ATL 12	Student cognition	61%
ATL 13	Teachers' perspective	55%
ATL 9	Specific teaching elements	39%
ATL 11	Heterogeneity in the context of subject-specific learning	37%
ATL 15	Educational system	34%
ATL 5	Extracurricular activities	34%
ATL 14	School development	32%

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**Table 7: Coding Frequency of Cognitive Processes**

<i>Code</i>	<i>Category</i>	<i>Coding Frequency</i>
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CPD 6	Create	63%
CPD 1	Remember	50%

ATL 5	Extracurricular activities	37%
ATL 14	School development	32%

# Cross Codings

Fields of Pedagogical Operation		FPO 1	FPO 2	FPO 3
Aspects of Teaching and Learning		Planning and design of learning situations	Reacting on student's demands during teaching processes	Evaluation of teaching processes
ATL 1	Learning content			
ATL 2	Objectives			
ATL 3	Curricula and standards			
ATL 4	Objectives of lessons			
ATL 5	Extracurricular activities			
ATL 6	Science			
ATL 7	Teaching Methods			
ATL 8	Subject-specific teaching concepts			
ATL 9	Specific teaching elements			
ATL 10	Media and educational material			
ATL 11	Heterogeneity in the context of subject-specific learning			
ATL 12	Student cognition			
ATL 13	Teachers' perspective			
ATL 14	School development			
ATL 15	Educational system			

Teacher Education Curriculum of University XY

The teacher students should learn to plan the learning content of a lesson

FPO 1		FPO 2		FPO 3																																														
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# CROSS-COURING

Fields of Pedagogical Operation		FPO 1	FPO 2	FPO 3
		Planning and design of learning situations	Reacting on student's demands during teaching processes	Evaluation of teaching processes
Aspects of Teaching and Learning				
ATL 1	Learning content			
ATL 2	Subject			
ATL 3	Curricula and standards			
ATL 4	Objectives of lessons			
ATL 5	Extracurricular activities			
ATL 6	Science			
ATL 7	Teaching Methods			
ATL 8	Subject-specific teaching concepts			
ATL 9	Specific teaching elements			
ATL 10	Media and educational material			
ATL 11	Heterogeneity in the context of subject-specific learning			
ATL 12	Student cognition			
ATL 13	Teachers' perspective			
ATL 14	School development			
ATL 15	Educational system			

Teacher Education Curriculum of University XY

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The teacher students should learn to plan the learning content of a lesson

...

## FPO 1

Planning and design of learning situations

**Table 8. Frequency of cross-coding for FPO 1**

Code	Category	Coding Frequency
ATL 7	Teaching Methods	50%
ATL 12	Student cognition	42%
ATL 1	Learning content	39%
ATL 8	Subject-specific teaching elements	34%
ATL 6	Science	32%
ATL 10	Media and educational material	29%
ATL 3	Curricula and standards	18%
ATL 2	School Subject	16%
ATL 4	Objectives of lessons	16%
ATL 11	Heterogeneity in the context of subject-specific learning	11%
ATL 13	Teachers' perspective	5%
ATL 9	Specific teaching elements	5%
ATL 15	Educational system	3%

## FPO 2

Reacting on student's demands during teaching processes

**Table 9. Frequency of cross-coding for FPO 2**

Code	Category	Coding Frequency
ATL 12	Student cognition	8%
ATL 7	Teaching Methods	5%
ATL 8	Subject-specific teaching elements	3%
ATL 1	Learning content	3%
ATL 2	School Subject	3%

## FPO 3

Evaluation of teaching processes

**Table 10. Frequency of cross-coding for FPO 3**

Code	Category	Coding Frequency
ATL 12	Student cognition	32%
ATL 10	Media and educational material	21%
ATL 1	Learning content	18%
ATL 8	Subject-specific teaching elements	16%
ATL 7	Teaching Methods	16%
ATL 13	Teachers' perspective	11%
ATL 2	School Subject	11%
ATL 6	Science	11%
ATL 4	Objectives of lessons	8%
ATL 15	Educational system	5%
ATL 3	Curricula and standards	5%
ATL 9	Specific teaching elements	5%
ATL11	Heterogeneity in the context of subject-specific learning	3%
ATL14	School development	3%

**Table 8. Frequency of cross-coding for FPO 1**

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ATL 11	Heterogeneity in the context of subject-specific learning	11%
ATL 13	Teachers' perspective	5%
ATL 9	Specific teaching elements	5%
ATL 15	Educational system	3%

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**Table 9. Frequency of cross-coding for FPO 2**

<i>Code</i>	<i>Category</i>	<i>Coding Frequency</i>
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ATL 8	Subject-specific teaching elements	3%
ATL 1	Learning content	3%
ATL 2	School Subject	3%

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ATL 6	Science	11%
ATL 4	Objectives of lessons	8%
ATL 15	Educational system	5%
ATL 3	Curricula and standards	5%
ATL 9	Specific teaching elements	5%
ATL11	Heterogeneity in the context of subject-specific learning	3%
ATL14	School development	3%

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8%

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3%

3%

3%



# PCK Model

**Table 2.1: Lists of Pedagogical Operation (PO)**

Code	Field of Pedagogical Operation	Subcategories
FPO 1	Planning and design of learning situations	<ul style="list-style-type: none"> <li>Time planning (class, lessons)</li> <li>Characterization of the starting situation (subject, resources, resources in the approach, professional or non-professional)</li> <li>Goals/aims: long-term lesson planning, planning the unit or lesson, planning a lesson</li> </ul>
FPO 2	Reacting on student's demands during teaching processes	<ul style="list-style-type: none"> <li>Students' focus on understanding, depth, use of contextual knowledge or social advantages, responding to students' requirements, responding to their learning complexity</li> <li>Learning completion with planning</li> </ul>
FPO 3	Evaluation of teaching processes	<ul style="list-style-type: none"> <li>Decisions</li> <li>Praxis</li> <li>Interdisciplinary</li> </ul>

**Table 3: Aspects of Teaching and Learning (ATL)**

Gr. No.	Category	Subcategories
ATL 1	Learning content	<ul style="list-style-type: none"> <li>Multiple representation</li> <li>Category systems for learning content</li> <li>Specific school-related content</li> <li>Structure and organization of learning content</li> <li>Didactical (re-) construction of subject-related knowledge</li> </ul>
ATL 2	Subject	<ul style="list-style-type: none"> <li>Relation to other subjects</li> <li>Definition of computer science education</li> <li>History of computer science education</li> <li>Relevance of the subject to the scientific discipline</li> <li>Objectives of the subject</li> <li>Legitimacy and relevance of the subject</li> </ul>
ATL 3	Curricula and standards	<ul style="list-style-type: none"> <li>Curriculum development</li> <li>Relation to other subjects</li> <li>Approach and structure of the curriculum</li> <li>Structural and content-related</li> <li>Actual examples of curricula</li> </ul>
ATL 4	Objectives of lessons	<ul style="list-style-type: none"> <li>Focus on education standards</li> <li>Competencies</li> <li>Learning objectives</li> </ul>
ATL 5	Extracurricular activities	<ul style="list-style-type: none"> <li>Interest cultivation</li> <li>Competence</li> </ul>
ATL 6	Science	<ul style="list-style-type: none"> <li>Subject discipline</li> <li>Computer science education as a scientific discipline</li> <li>Relationship between teaching of the subject and the scientific discipline</li> </ul>
ATL 7	Teaching Methods	<ul style="list-style-type: none"> <li>Didactical strategies</li> <li>Methodological principles</li> <li>Subject-specific teaching methods</li> </ul>
ATL 8	Subject-specific teaching concepts	<ul style="list-style-type: none"> <li>Introductory lessons</li> <li>Programming classes</li> <li>Historical approach</li> <li>Lab-based teaching</li> <li>Experiments</li> <li>Tasks and assignments</li> </ul>
ATL 9	Specific teaching elements	<ul style="list-style-type: none"> <li>Application of hardware and software</li> <li>Toolboxes</li> <li>Employment of media</li> </ul>
ATL 10	Media and educational material	<ul style="list-style-type: none"> <li>Age</li> <li>Gender</li> <li>Ethnic background</li> <li>Family socialization</li> <li>Individualities</li> </ul>
ATL 11	Heterogeneity in the context of subject-specific learning	<ul style="list-style-type: none"> <li>General subject-related cognitive aspects</li> <li>Individual learning, diagnostics, performance evaluation and assessment</li> <li>Cognitive aspects</li> <li>Collaboration</li> <li>Curricula</li> <li>Qualification</li> <li>Motivation</li> <li>In-service training</li> <li>Teacher competence</li> <li>Persons</li> <li>Quality management</li> <li>School profile</li> </ul>
ATL 12	Student cognition	<ul style="list-style-type: none"> <li>School type</li> <li>Environment</li> <li>Orientation-related aspects of subject</li> </ul>
ATL 13	Teachers' perspective	
ATL 14	School development	
ATL 15	Educational system	

Fields of Pedagogical Operation		FPO 1	FPO 2	FPO 3
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**Current Work**

# Expert Interviews

## Sample

18 cognitive Scenarios  
3 PCK Stages (FPOs)  
40 Experts

## Methodology

Critical Incident Technique

Critical incident: event or problem, which stimulates or demands activities and operations by the interviewee

# Sample

18 cognitive Scenarios

3 PCK Stages (FPOs)


40 Experts

# Methodology

## Critical Incident Technique

Critical incident: event or problem, which stimulates or demands activities and operations by the interviewee

# Methodological Approach & Study Design

- Development of a competence framework model
- Empirical requirements analysis 
- Validation of the competence model
- Development of a measurement instrument
- Measuring competences of future Computer Science teachers in a large sample
- Model and test validation
- Curricula recommendation

**Thank you very much for your attention!**

**Any questions?**