Development of a Competency Model for Computer Science Teachers at Secondary School Level

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Abstract— In order to identify important competencies required for teaching computer science in schools, the research project KUI (Competencies for Teaching Computer Science) granted by the Ministry of Education and Research (BMBF) was founded. At this point in time, there is no consistent competency model for training computer science pre-service teachers in Germany. The development of an adequate model is an important step to establish outcome-oriented guidelines and curricula recommendations. The first framework of a competency model is structured into the dimensions of subject matter knowledge (CK), pedagogical content knowledge (PCK) and non-cognitive competencies (NCC). This article concentrates on the development of the PCK and NCC competency model. It describes our methodological approach, our results of expert interviews to refine the model, and shows an overview of the first competency definitions.

Keywords— Computer science education; competency measurement; competency model

I. INTRODUCTION

The focus on the exploration of teachers’ competencies has grown in the last two years. Several well-known surveys like “Professional Competency of Teachers, Cognitively Activating Instruction, and Development of Student’s Mathematical Literacy” (COACTIV) [1], and “Teacher Education and Development Study in Mathematics” (TEDS) [2] researched the field of competencies based on Shulman’s definition [3]. Unfortunately, no competency model for computer science teachers exists to date.

A study in the State of Bavaria, Germany, showed that computer science (CS) teachers have difficulties to transfer didactical concepts in class. Moreover, the study revealed that CS teachers are unhappy with their lesson planning and the implementation afterward [4]. The project group “Competencies for Teaching Computer Science” (short KUI) was founded in summer 2012 and is funded by the German Federal Ministry of Education and Research (BMBF) until the end of June 2015. The aim of our project group is to develop a competency model for CS teachers in Germany. By means of the competency model, we want to create a measurement instrument to ascertain what competencies CS pre-service teachers need to achieve. Our competency model and our findings will help us to compose curricular recommendations for teacher preparation. As such, prospective CS teachers will receive a better CS teachers’ education making it easier for them to transfer their knowledge to the classroom. The structure of our competency model is based on other successful investigations that are mentioned above. According to these prominent surveys, teachers’ expertise can be divided into the following fields:

1. Cognitive abilities and knowledge:
   - Subject matter knowledge,
   - Pedagogical knowledge,
   - Pedagogical content knowledge,

2. Motivational, volitional and social dispositions and skills:
   - Professional convictions, values and beliefs,
   - Motivational orientations.

Since the goal of our project is to identify competencies that are needed specifically for teaching CS, we don’t consider Pedagogical Knowledge, which is supposed to be more or less common to all school subjects. Beliefs and motivational orientations are important factors that influence how teachers behave in their classroom [5] and how they cope with a changing environment [6].

Our framework is theoretically based on the competency notion of Weinert (2001). Therefore, competencies are understood as performance dispositions to solve complex situations. They are acquired and can be changed by learning (Weinert 2001). As this research field is sparsely investigated up to now, the model should represent the wide range of domain-specific teaching competencies to establish a basis for future measurement and evaluation purposes. Therefore, our project is focused on three fields: (1) Subject

Matter Competencies, (2) Pedagogical Content Knowledge and (3) Non-Cognitive Competencies.

The structure of our competency model can be seen in figure 1.

![Fig. 1 Structure of a CS Competency Model](image)

This paper deals with the development of a competency model focused on Pedagogical Content Knowledge (PCK) for CS teachers and the results of a competency model focused on Non-Cognitive Competencies (NCC). This study, is an empirical study using qualitative content analysis and expert interviews for the development of models. In the first section of this paper, we describe the derivation and the structure of the category system that we used as a basis. Moreover, in the next section, we describe our methodological approach of using expert interviews to refine the model and the corresponding results. In addition, we show the results of the expert interviews in section V and the development of the competency definitions in section VI.

In Figure 2, we show the project’s methodological approach to establishing a refined empirical competency model. The figure also serves you as a guideline throughout this paper.

![Fig. 2 Methodological Approach](image)

II. DERIVATION AND STRUCTURE OF OUR PCK CATEGORY SYSTEM

For the design and empirical validation of a suitable model of PCK for CS, we followed a combined top-down and bottom-up approach, aiming to design models that are well founded on theory on the one hand and empirically validated on the other. As already explained in [15] and [14], we started our work on PCK by developing a literature-based category system that could be used as a common starting point for the analysis of teacher education curricula. For this purpose, we performed a qualitative text analysis according to Mayring [22] on about 20 sources that we had considered relevant. Basically, these sources belong to different groups.

First, we considered general definitions of PCK, as Carlsen [7], who rearranged the concept of Shulman [8] dividing Shulmans “curricular knowledge” in a subject specific and an interdisciplinary component, distinguishing Pedagogical Knowledge (PK), Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK). Additionally, he partitioned PCK as follows: students’ common misconceptions, specific science curricula, topic-specific instructional design and purposes for science teaching.

Second, we coded several proposals for Teacher Education standards, starting with [9], followed [10] and the German standards of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK, see www.kmk.org) [11].

Third, we investigated some definitions of PCK for other school-subjects. For example, the so-called Michigan Group
has proposed a subject specific knowledge framework for mathematics [12]. For the same subject, two broad high-quality studies investigated the effects of the knowledge facets of mathematics teachers on their teaching success in Germany: COACTIV [1] and TEDS [2]. Each one has presented its own structure of PCK. In 2011, Lindmeier presented her very comprehensive dissertation about PCK in mathematics [20]. Besides mathematics, we have found conceptualizations for the science oriented subjects physics and biology. Regarding the PCK of physics teachers, Magnusson et al. have presented a specific model [13]. Furthermore, Riese has presented his dissertation that was focused on PCK for physics [14]. For Biology, Schmelzing has developed another categorization [15]. For the subject of English language, Grossman [16], [17] has posed a set of questions in order to perform a qualitative analysis of the PCK of teachers of English language.

Fourth, we found several explicit conceptualizations of PCK for CS. Saeli presented one recently [18]. Although it is restricted to programming, it might be regarded as a starting point. Before, Koppelman had published some reflections of PCK for CS [19]. Regarding the required competencies for teaching CS, all 16 German states defined a set of common subject-specific standards for teacher education in 2008 [11], also relating to CS.

Next, assuming that teachers should also be educated as researchers, categorizations of CSE research should be considered for PCK categories as well. For example, Fincher and Petre have proposed 11 research categories [5]. A similar list was presented by Kinnunen [20]. Unfortunately, the original publication seems not to be available anymore. Therefore, we refer to [21]. At the ACM ITiCSE conference 2011 in Darmstadt, a working group developed a category system called Darmstadt Model, originating from the research question, “Which factors are relevant for computer science education in schools?” [22]. This model could be relevant for PCK.

Additionally, we considered the model for didactical reconstruction of lessons that was recently presented by Diethelm et al. [23] recently, and was based on the model of Kattmann [24]. We suggest that these categories should also be considered as a part of the OCK, as this is one of the most important tasks that teachers perform in their professional work.

Finally, there are several seminal textbooks for subject-matter didactics that might contribute new elements. Generally considered as important and influential in Germany, one could regard the following: Hazzan et al. [25] from Israel, Hubwieser [12] and Schubert & Schwill [26], both from Germany and Hartmann et al. [27] from Switzerland.

The outcome of the literature survey was a category system that comprised 18 top-level categories. Subsequently, and as already described in [28], we identified three of the top-level categories as specific “Fields of Pedagogical Operation” (FPO, see table 2), which seemed to be orthogonal to the remaining 15 categories, which we called “Aspects of Teaching and Learning” (ALT, See table 3.). In this manner, we obtained a two-dimensional model with the FPOs as columns and the ALTs as lines (See table 1).

<table>
<thead>
<tr>
<th>Table 1. The two dimensional model of PCK</th>
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<tbody>
<tr>
<td>FPO 1</td>
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<td>ATL 1</td>
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<tr>
<td>ATL 15</td>
</tr>
</tbody>
</table>

The first dimension, FPO, represents the three natural stages of the practical process of teaching and learning in the classroom, predominantly taking place before (FPO 1), during (FPO 2), and after the lesson (FPO 3)(see table 2).

<table>
<thead>
<tr>
<th>Table 2. Fields of Pedagogical Operation (FPO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. No.</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>FPO 1</td>
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<tr>
<td>FPO 2</td>
</tr>
<tr>
<td>FPO 3</td>
</tr>
</tbody>
</table>

The second dimension encompasses the remaining pedagogically relevant ATL, which are more or less relevant to all FPOs of the first dimension. This second dimension contains 15 categories on level 1, which can be arranged in five groups. As there are many “crossing” associations, those groups should not be regarded as hierarchically ordered (see table 2).

<table>
<thead>
<tr>
<th>Table 3. Aspects of Teaching and Learning (ALT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. Nr.</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Group 1: Subject and curriculum related Issues</td>
</tr>
<tr>
<td>ATL 1</td>
</tr>
</tbody>
</table>
III. THEORETICAL DERIVATION AND STRUCTURE OF OUR NCC COMPETENCY CATEGORY SYSTEM

As our heuristic framework of competency is theoretically based on the competency notion of Weinert [29], our model also includes facets of motivational, volitional, and social dispositions and skills. The derivation of competency-relevant categories, including facets of beliefs, motivational orientations and social-communication skills for teaching CS is mainly based on analyzing three types of theoretically and normatively oriented documents. These analyses serve to collect the broad range of non-cognitive facets possibly relevant to CS teachers and being reduced and refined in the further steps.

First, recent empirical studies from related fields of research like mathematics [2] and the natural sciences (e.g. [14]), serve as relevant references to derive the overall structure of the model including the non-cognitive aspects. These categories have provided empirical evidence in related subject areas. Furthermore, teacher education models presented in large-scale studies and expert papers [3] are considered especially to structure the dimensions of the competency model. These subject-unspecific models and standards are analyzed with regard to their specification for teaching CS. Third, documents from the field of CS, particularly developed by the ACM (Association for Computing Machinery) and IEEE (Institute of Electrical and Electronics Engineers 2012), are considered to structure subject-specific non-cognitive facets for computer science. Additionally, standards from the field of school education, for example the K–12 Computer Science Standards (CSTA 2011) are taken into account, assuming that standards for students are basically applicable to the subject teachers.

Table 4 shows the theoretically-derived category system for the Non-Cognitive-Aspects.

<table>
<thead>
<tr>
<th>Cat.</th>
<th>Category</th>
<th>Subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATL 13</td>
<td>Teachers’ perspective</td>
<td>- Collaboration</td>
</tr>
<tr>
<td>ATL 14</td>
<td>School development</td>
<td>- Policies</td>
</tr>
<tr>
<td>ATL 15</td>
<td>Educational system</td>
<td>- School type</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cognitive activation</td>
</tr>
<tr>
<td>- Core tasks</td>
</tr>
<tr>
<td>- Qualification</td>
</tr>
<tr>
<td>- Motivation</td>
</tr>
<tr>
<td>- In-service training</td>
</tr>
<tr>
<td>- Teaching experience</td>
</tr>
</tbody>
</table>

**Table 4 Theoretical derived category system for the Non-Cognitive-Aspects.**
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Group 1: Social and Communication Skills</th>
<th>Group 2: Motivational Orientations and Self regulation</th>
<th>Group 3: Beliefs and Attitudes</th>
</tr>
</thead>
</table>
| NCC 1 | Empathy: ability to change perspectives and roles | - Ability to change into pupil’s perspective  
- Ability to empathize with users and non-informatics persons | - Willingness to deploy new and unknown CS approaches |
| NCC 2 | Professional communication | - Use adequate tools for communication and cooperation  
- Cope with dynamics of oral, written, and electronic team and group communication  
- Ability for reading, understanding and summarizing technical material  
- Ability and willingness to criticize constructively  
- Presentation of CS topics  
- Communicate professionally about CS topics | - Willingness to improve teaching abilities and didactical knowledge  
- Willingness to fulfill informatics tasks successfully  
- Willingness to improve informatics abilities and knowledge |
| NCC 3 | Cooperation | - Project management and methods  
- Cooperation with colleagues  
- Use connections in and beyond CS  
- Willingness and ability to cooperate to solve CS problems  
- Willingness to pick up ideas of other team members  
- Willingness to work according to agreements  
- Make and fulfill agreements in a team | - Self-organizational competency  
- Commitment and Engagement  
- Emotions attending work  
- Distance / resilience |
| NCC 4 | Motives for choosing the profession | - Didactical motivation  
- Contribution to society  
- Self concept related with the profession  
- Own experiences with learning and teaching  
- Extrinsic motivation  
- Pedagogical motivation  
- Subject matter motivation | - Role-perception |
| NCC 5 | Intrinsic motivational orientations | - Enthusiasm for subject matter CS  
- Enthusiasm for teaching CS | - Static aspects of CS worldviews/transmissive  
- Dynamic aspects of CS worldviews/constructivist |
| NCC 6 | Self-efficacy | - Self-efficacy referring to specific tasks as CS teacher  
- Self-efficacy referring to the profession as CS teacher | - Beliefs Concerning Learning and Teaching in CS  
(constructivist and transmissive orientation)  
- Beliefs concerning classroom-management  
- Expectations for informatics literacy and professional practice  
- Beliefs concerning pupils in CS lessons |
| NCC 7 | Task and performance orientation | - Performance approach  
- Mastery approach | - Beliefs Concerning Learning and Teaching in CS  
(transmissive orientation)  
- Beliefs concerning classroom-management  
- Expectations for informatics literacy and professional practice  
- Beliefs concerning pupils in CS lessons |
| NCC 8 | Openness towards new ideas and demands in teaching computer science | - Willingness to take part in school development  
- Willingness to use recent educational research results  
- Avoid mechanistic CS | - Theoretical beliefs and attitudes  
- Beliefs Concerning Security Policies, Laws and Computer Crimes  
- Beliefs Concerning Privacy and Civil Liberties  
- Beliefs Concerning Intellectual Property  
- Beliefs Concerning Analytical Tools  
- Perceive and anticipate effects of CS systems  
- Attitudes towards sustainability  
- Beliefs concerning social context /impacts  
- Beliefs concerning the content of teacher education  
- Beliefs concerning the tasks of teachers  
- Beliefs concerning the functions of schools  
- BELIEFS CONCERNING EDUCATIONAL POLICIES, STANDARDS AND REFORMATIONS REGARDING CS |
IV. EXPERT INTERVIEWS

We used expert interviews to refine our competency models and to form competency definitions in the end. This section deals with the methodological approach and the realization of our expert interviews.

A. Methodological approach

A restriction on exclusively theoretically-derived competencies would risk that the reference of competencies to complex requirements in real situations is neglected or disregarded. For this reason, an additional step is necessary in order to determine competencies more reliably; that is, ensuring an empirical access to determine the relevant competencies. Expert interviews were conducted within which the Critical Incident Technique (CIT) [30] was deployed, representing an appropriate empirical approach in order to detect the relevant competencies, that belong to the PCK of CS teachers.

In the first step of the empirical procedure, the expert interviews were conducted. From January until March 2014, 23 experts in CS education were interviewed. The interviews were based on a structured questionnaire manual and included questions about the expert status of the interviewees and several scenarios concerning typical and critical school situations: Every scenario was divided into the three FPO parts of our category system (see section II):

- Planning and design of learning situations;
- Reaction to student demands during teaching processes;
- Evaluation of teaching processes.

The questions for each scenario were based on the second dimension of our category system, i.e., ATL. Therefore, we could cover most of the categories. The following scenario is one example scenario from our questionnaire manual (original in German):

**Planning:**
After a few hours on object-oriented modeling, you now want to start with the topic "Object Oriented Programming". You are planning that, after some time, your students should know what classes and objects are and that they are able to program their first small program.

**Questions:**
- How would you proceed to plan the lesson so that your students can actively acquire the learning content?
- What are the difficulties in relation to the planning of the lesson that can occur in this situation?

**Additional Questions:**
- By what didactic concepts, methods, media and social forms, are you preparing this lesson?
- How do you take the knowledge and skills requirements of your students into account when you are planning this lesson?
- How do you take the motivation of pupils in relation to computer science topics into account when you are planning this lesson?

**Reaction:**
After a few lessons your students’ task is to implement small object-oriented assignments in Java. During the discussion of these assignments, you notice that some students are not able to distinguish between a class and an object.

**Questions:**
- How would you react in this situation?
- What other difficulties may arise on the students’ part when solving the assignments in this situation?
- What heterogeneous learning abilities of your students exist in that situation?

**Additional Questions:**
- On what would you pay attention to help your students with solving the assignment in this situation?
- How would you provide feedback during the assignment processing in this situation?
- How would you respond to difficulties/problems of the assignment?
- How would you respond to difficulties by heterogeneous conditions?

**Evaluation:**
At the end of the semester, you want to determine whether your students have understood the key concepts of object-oriented programming.

**Questions:**
- How would you proceed to evaluate the learning results and report back to the students?
- What problems can occur in the assessment of learning outcomes?

**Additional Questions:**
- How can you explain potential learning outcomes of your students?
- What conclusions can be drawn from the learning outcomes?
- Which aspects of the performance of the students would you assess?

Altogether, 18 scenarios were used in the interviews. To limit the duration of the interviews to an appropriate length, each interviewee was only interviewed using three scenarios (two cognitive scenarios and one non-cognitive scenario). Each
The interview lasted about 60 minutes. The interview included the following steps:

- The interviewee was welcomed and introduced to the underlying notion of competency and the CIT. Furthermore, the sensible handling of with the data was guaranteed.
- After that, the interviewee was asked to give some personal data such as occupational tasks, education, and experience.
- Presenting each scenario to the interviewee and encouraging him or her to give details on his/her intimate proceedings and approaches to solving the presented PCK problem.

The recorded expert interviews were transcribed in full and examined by means of qualitative content analysis according to Mayring [31] with the tool MaxQDA [32].

B. Example of results

Our PCK model (see section II) was refined by means of the results we could gather from the expert interviews. To analyze the interviews we created a manual covering the whole model. For each category and the related subcategories we agreed on a definition and identified an anchored example. In that way, we could ensure that each person who analyzed the interviews (called "coder" in the following) would have the same understanding of the categories.

Three coders from our research group collaborated in analyzing the interviews. Before they started with the analysis, all of them agreed to coding rules i.e. (1) every coding has to be assigned to both dimensions, (2) the smallest coding unit is a sentence and the biggest coding unit is a unit of meaning; and (3) codings, which are citations of the collection of expert statements, were supposed to be assigned to the subcategories—e. g. for example for FPO 3: Evaluation of teaching processes: “A. Techniques”, “B. Criteria”, and “C. Derive consequences”.

The content analysis provided results that basically support the theoretically derived competency model. This led us to the conclusion that the decision for this research method was appropriate. The set of data allows us to refine the competency model building on this empirical study (see section VI).

V. EXPERT INTERVIEWS RESULTS

In total, we conducted 23 expert interviews regarding the typical and critical school situation to refine our PCK and our NCC model. Our aim was to ascertain – by means of the experts’ statements—what categories are used while planning and/or designing a teaching situation, reacting to students’ demand during teaching, or evaluating a teaching process. The category system for PCK contains three categories in the first dimension (FPO) and 15 main categories on the second dimension (ATL) (see section II). Categories that didn’t contain a coding were initially excluded from the PCK model. Altogether, we had 795 codings for the first dimension and 2847 codings for the second dimension. Figure 3 shows the frequency for the first dimension. The statistic displays the main categories, which comprise all the subcategories (see section II).

Figure 4 shows the coding’s frequencies for the second dimension. The statistic illustrates that there were no codings for categories like “ATL5: Extracurricular Activities and ATL14: School Development. Like Figure 3, Figure 4 shows only the main categories of our category system but comprises all codings of the subcategories. All subcategories, which don’t contain any codings, were also removed from our PCK model, i.e., “ATL1: Category System for Learning Content, ATL2: Definition of CS Education, ATL3: Selection and Commitment, ATL4: Focus on Educational Standards, ATL6: Subject Discipline and CS Education as a Specific Discipline, ATL8: Historical Approach, ATL10: Experiments”. ATL 1: Learning content contains the subcategory, “Specific school-related content”. This subcategory contains important codings for the subject matter category system, which is the first field of our study (See I). Therefore, we shifted don’t consider the codings for our PCK model.

The NCC category system contains in total 2019 codings.
VI. DEVELOPMENT OF COMPETENCY DEFINITIONS FOR PCK

This section deals with the evaluation of the expert interviews to convert our category system into a competency model, with elaborate competency definitions for CS teachers. We analyzed every single category by clustering and summarizing every coding to a competency definition in the end. For the analysis, we investigated all codings of one category to see if there were similar ones and merged them. Furthermore, we paraphrased the codings to general sentences that express the meanings of the occurred codings. Finally, these sentences were formulated as observable competencies that are derived from the underlying literature and confirmed by the expert interviews.

There were several competencies related to a specific category, while other categories only contain one (for example Science) contained only one. In a final step, we took the clustered and summarized codings and formed a competency definition for each leftover category. In particular, we took the criterion, all competencies have to be observable, into account. Furthermore, we made sure that all definitions had the same sentence structure to avoid confusion. Table 5 shows a competency definition example of our first dimension, i.e., FPO (see section II), and Table 6 illustrates an example of the second dimension of our competency model, i.e., ATL (see section II).

After revisiting all the summarizing sentences, we could confirm 18 categories in two dimensions derived from literature. In the end, there were 79 competencies formulated in the way described above.

Table 7 shows a competency definition example of the NCC competency model.

<table>
<thead>
<tr>
<th>Planning and Design a Learning Situation (1st dimension: FOP 1)</th>
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<tbody>
<tr>
<td><strong>Planning and Design of a learning situation</strong></td>
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<tr>
<td><strong>Time planning, Time allocation</strong></td>
</tr>
<tr>
<td>The teacher is in a position to review their planning of CS lessons in terms of time aspects. This comprises temporal planning of CS lesson as well as individual assessment of students learning processes.</td>
</tr>
<tr>
<td><strong>Explanation of planning</strong></td>
</tr>
<tr>
<td>The teacher is in a position to evaluate her/his</td>
</tr>
</tbody>
</table>

Table 6 Competency definition for “Media and educational material” (2nd dimension: ATL 10)

<table>
<thead>
<tr>
<th>Media and Educational Material</th>
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<tbody>
<tr>
<td><strong>Textbooks</strong></td>
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<tr>
<td>The teacher is in a position to select appropriate material, like textbooks, scripts or films for her/his lesson and to provide that material to her/his students. They are also able to create an advanced organizer together with the class.</td>
</tr>
<tr>
<td><strong>Unplugged Media</strong></td>
</tr>
<tr>
<td>The teacher is in a position to design a computer science lesson with no computers, where pupils learn to solve computer science problems without using a computer e.g. create object cards or learn sort algorithm by sorting a living map.</td>
</tr>
<tr>
<td><strong>Application of Hard and Software</strong></td>
</tr>
<tr>
<td>The teacher is in a position to select appropriate programming and modeling software. The teacher is in a position to promote computer science learning processes by using different programming languages. The teacher is in a position to use various media such as a projector or an interactive whiteboard in the classroom.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competency relevant beliefs about the subject computer science</th>
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</thead>
<tbody>
<tr>
<td><strong>Beliefs about the subject computer science</strong></td>
</tr>
<tr>
<td>Teachers are convinced that superordinate strategies and principles make up the subject computer science and are relevant to all sections of subject. Teachers are convinced that the core of computer science consists of processes that can always be traced back to relationships between information and planning for a CS lessons by means of professional learning and psychological criteria.</td>
</tr>
</tbody>
</table>

Granularity

The teacher is in a position to plan entire teaching units, as well as individual CS lessons.
I. DISCUSSION

The aim of our study was to develop an appropriate competency model for CS teachers and a corresponding instrument to measure CS pre-service teachers' competencies for teaching CS in Germany. We achieved our first milestone by developing a competency model for PCK and for NCC, which we described in this paper. All together, we interviewed 23 experts to refine our empirically validated category systems and to develop competency definitions for CS teachers based on that system. Our next milestone is the development of a measurement instrument to measure CS pre-service teachers' PCK to figure out what PCK these students cover and what competencies have to be improved.

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