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Different dimensions of knowledge in teacher education - towards a typification

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Abstract
The paper presents a typology of dimensions of 'knowledge' related to teacher education and professional practice. It departs from the observation that this theme is determined in many different ways and as a whole seems very difficult to capture. The purpose is to contribute to further clarification. Three dimensions of teacher knowledge are presented: 1) Ways of handling knowledge, 2) Modes of knowledge, and 3) Knowledge in a content perspective. Referring to the first dimension, it is emphasized that student teachers need to develop both a critical consciousness of knowledge, as well as abilities for enacting knowledge and for constructing knowledge. 'Enacting knowledge' includes taking different perspectives and using various types of knowledge to understand and handle a professional situation. 'Constructing knowledge' refers, for example, to student teachers researching professional challenges. Dimension 2 focuses on different modes in which teacher knowledge can appear with the subcategories global evidence, local 'evidence', and theory and philosophy. Dimension 3 refers to knowledge in a content perspective, with an open list of typical content in teacher education. The potentials and perspectives of this typology are discussed, including examples of how it can be used and also reference to professional knowledge and professionalism.

Keywords: knowledge types; teacher education; professional knowledge; typification; teacher knowledge

Introduction
The basis for professional work as a teacher lies today, as in previous times, in the capacity to perform work informed by and validated against shared knowledge and conventions of practice. But at the same time, this knowledge base is not stable, but rather contested

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and subjected to continual transformation (Markauskaite & Goodyear, 2014). Furthermore, professional education in general builds on a heterogenic group of knowledge-bases (Gilje, 2017; Grimen, 2008). Various types of knowledge, skills and values are inevitably involved when acting professionally, and it is crucial to avoid a reductionist understanding of the knowledge base (Gilje, 2017). Conditions for professional practice are however changing in the 21st century. New forms of public management challenge the professional judgment and autonomy historically associated with the teaching profession (Carr, 2014; Kinsella & Pitman, 2012). So, the question about what knowledge student teachers and/or in-service teachers[2] need to act with a professional agency (Eteläpelto et al., 2013) in this complexity is as valid as ever. The present paper sets out to develop a typification of how 'knowledge' is used as a conceptualization in discussions about teacher education. The theoretical background will be included along with the presentation of dimensions, hence this rather short introduction.

Research aim

The purpose is to contribute to further clarification of a research field 'teacher knowledge' containing many perspectives and levels and different kinds of issues. Our hope is that a systematization can help with conceptual clarity and transparency and in this way enrich and qualify the dialogues across the groups of stakeholders involved in teacher education. Discussions about knowledge and scientific theory have a very long and complicated history. The aim by developing a typology is to offer a first stepping stone into the huge theme about knowledge in teacher education and we do this by using references to more current debates and contributions to the field. The theoretical analyses are guided by the question of how to typify various ways of using the concept of 'knowledge' in current international theoretical and empirical discussions of teacher education and professional practice. In other words, the aim is to provide a meta-perspective on the question about teacher knowledge. See more below about limitations in the use of references in the paper focusing in particular on contemporary research and knowledge-discourses from the Norwegian context.

Hence, the research aim is primarily analytic and descriptive and less normative. The typology is not meant to illustrate how student teachers can construct knowledge and skills, or how teacher education can contribute to these learning processes. The typology (only) represents the answer to the question about 'which' dimensions. We are, however, aware that pointing out categories cannot be a 'clean' analytical project. The way we think about teacher education, including the vision that student teachers from day one should be positioned as actors working with knowledge in a range of ways, not just as 'consumers,' will inevitably permeate the analyses.

[2] Below we write (student) teachers to imply that the typology is relevant in relation to both pre- and in-service teachers.

Method

The dimensions have been developed in a truly iterative process over time, formulated in their first versions based on a growing awareness of the importance of these questions of 'knowledge' in our work as teacher educators and researchers. The construction of the dimensions has in the process been informed by a broad reading of the (research) literature, guided by the question to each article or piece of theory about main ways teacher knowledge is framed. The construction and iterative development of each dimension and subcategory have led to identifying a need for one more dimension and/or subcategory until we have reached what we see as a 'saturated' description. We strive to provide transparency about these developing rationales. The claim about 'saturation' is not to imply that there are no more subcategories to be constructed, but rather a claim that the illustration of and argumentation about a certain dimension is saturated. We still see the typology presented as a kind of first version. The dimensions as presented have gradually been constructed and re-constructed based on discussions in the research team referring to both the literature and our own research and experiences, but also in a process of presenting the work for peers from Denmark, Norway and Sweden, and using their input to move on. Furthermore, in the perspectives below, we invite for further elaboration from colleagues in the field.

Hence, we will argue, that the processes of securing communicative and pragmatic validity (Sandberg, 2005) are crucial when developing a typology to be used to mediate professional discussions about teacher knowledge. However, as Sandberg (2005) stated, communicative and pragmatic validity can help check the coherence of certain interpretations and test the knowledge produced in action, but it may encourage the search for only consistent and unequivocal interpretations, and by doing so overlook cases of ambiguity, complexity, and multiplicity. So, we refer also to transgressive validity as a quality criterion (Sandberg, 2005). Before reaching 'saturation' we have deliberately searched for differences and contradictions. The intention is to present a typology that is relatively simple and provides an overview but to present it in a way in which we are acknowledging the complexity of the field.

Searches in the literature using the platform EBSCO-host with the databases Academic Search Premier, Eric, APA PsycInfo and Teacher Reference Center have been part of the process when closing in on a particular subcategory. But referring to the iterative processes we will stress the (limited) role and methodological position of the systematic searches compared to a systematic review. The references cited in the article are (only) illustrations from the full body of literature. We include in the references some of the international single study papers but prioritize reviews and research handbooks (e.g., Carlson, & Daehler, 2019; Markauskaite & Goodyear, 2014). Furthemore, we prioritize single-study papers with research from a Scandinavian context, i.e., from Norway. There is in Norway an increased research-orientation in teacher education with a 5-year professional master program and the model is currently used in the Norwegian research project

TEQ21 (https://teq21.oslomet.no). The description of the dimensions below elaborates on how teacher knowledge is framed in each of the papers or pieces of theory, including how the authors refer to teacher practice, implications for teacher education and student teachers' competencies.

How to understand and define 'knowledge'

When setting out to typify various ways of conceptualizing teacher knowledge we need to start by defining the term knowledge. Like Markausskaite and Goodyear (2014), we understand knowledge in the broadest sense to include both conceptual and procedural knowledge, tacit as well as explicit knowledge and personal as well as public knowledge. Furthermore, it can be difficult to separate 'knowledge,' often referred to as factual and logically organized ideas, from 'beliefs,' referring to something individuals feel to be true. Southerland, Sinatra and Matthews (2001) claimed that a distinction is hopelessly blurred at the empirical level. We will return to teacher beliefs later, but for the time being the most important declaration is that knowledge, as we use the term, includes both knowing about things, referred to by Biggs and Tang (2011) as declarative knowledge, and knowing to do things, or functioning knowledge. Hence, we include in the term 'knowledge' what in some contexts would be considered skills or competencies.

Another defining question is how we understand 'professional' knowledge in particular. We will start by presenting the typology and elaborate further on professional knowledge and professionalism after this. However, it is important here to emphasize, that the question about how to understand teacher knowledge like other epistemological questions takes different forms in different traditions and paradigms. Zeichner (1983) refers to four paradigms of teacher education: 'the Behavioristic, Personalistic, Traditional-Craft and Inquiry-oriented paradigms'. Hence, fundamental epistemological issues are woven into the question about teacher knowledge and are explicitly or implicitly addressed in the research and theory informing the typology. An in-depth paradigmatic discussion is beyond the scope of the paper, but one discussion in particular will be elaborated below, namely how to understand the role of research in teacher education, referring e.g. to a mainly inquiry-oriented paradigm widespread in contemporary research.

A final basic and methodological consideration is if and how this work contributes to the research field. Is this kind of typology something new? We refer continuously throughout the presentation to the implicit and/or explicit use of the dimensions and subcategories in the literature. Hence, the dimensions do not represent new ideas. None of the theoretical and/or research sources do however draw on and combine all suggested dimensions. The focused searches in the literature did not reveal a similar typology. But there are similar initiatives, for example, Menter (2016) discussed conceptions of teaching illustrating what teachers should know and the ideas that should shape the education of teachers in a model with three overlapping areas of subject and pedagogical

knowledge, practical experience and research literacy. And a range of models are presented in the research field of pedagogical content knowledge (PCK) (Carlson & Daehler, 2019). But as discussed below, the various representations of PCK do have another and narrower point of departure than the present work, primarily the perspective of teacher knowledge in a content perspective, while the typology presented in the present paper also includes how to handle knowledge and various modes of knowledge.

Dimension 1: Ways of handling knowledge

We start by illustrating the two first dimensions in a matrix (Figure 1).

Figure 1: Two dimensions of knowledge in teacher education

1. Ways of handling knowledge → / 2. Modes of knowledge ↓	1A: Consciousness of Knowledge	1B: Enactment of Knowledge	1C: Constructing Knowledge
2A: Global evidence			
2B: Local 'evidence'			
2C: Theory and philosophy			

Dimension 1 refers to different ways to handle and deal with knowledge in teacher education. A central point is a combination of 'doing' and 'knowledge.' It addresses an ability not only to know something but also to do something integrating this knowledge—in other words, the synergy between declarative and functioning knowledge aspects (Biggs & Tang, 2011). This perspective on teacher knowledge is relevant because teacher education is an education of applied sciences. The knowledge that student teachers meet and develop is constantly framed by the perspective of current and future practice in the school arena (Puustinen et al., 2018). Meeting knowledge is not only a question of using or transforming knowledge into practice. The student teachers' task of translating and transforming educational knowledge into an in-school practice involves other types of handling knowledge than just 'using' which we will elaborate on below.

Subcategory 1A: Consciousness of knowledge

We will refer to three different ways of handling knowledge. The first subcategory implies the ability to establish a meta-perspective on knowledge including, being able to identify and categorize different types of knowledge. This includes a critical view toward knowledge, for example that (student) teachers are able to discuss and judge the predication and different kinds of knowledge, but also that they can critically assess the validity

of a claim, e.g., in contemporary debates about 'what works' in teaching. From the literature base, Hermansen and Mausethagen (2016) is an example of including this approach when discussing teacher education. They stress that "student teachers must be prepared in a critical way to analyze different kinds of knowledge and their implications on teacher work" (Hermansen & Mausethagen, 2016, p. 104). Munthe and Haug (2010) likewise referred to student teacher 'research' being a part of many contemporary teacher education programs, including aims of student teachers developing an understanding of possibilities and limitations related to interpreting research results. Likewise, Lillejord and Børte (2017), in a research summary, referred to teachers' critical inquiry as part of their professional work.

Summing up, this subcategory addresses the same metaperspective as the article, inviting analysis and discussion of teacher knowledge from an educational and professional perspective. Referring back to the introduction, this critical consciousness is as valid as ever.

Subcategory 1B: Enactment of knowledge

This subcategory highlights how (student) teachers can act with and use knowledge in different ways. We depart from Weick's conceptualization of 'enactment' (Weick, 1995). Instead of seeing the relationship between subject (student teachers) and phenomena in the outside world (knowledge) as a dichotomy, the concept of enactment construes the relationship as integrated and interwoven. The two elements (subject and outside world) are not isolated phenomena but creating or producing each other in mutual processes. The student teacher is thereby positioned not as a passive consumer of knowledge but as a 'reflective teacher' (Dewey, 1910) - a subject with or 'in' agency (Eteläpelto et al., 2013).

We will point to three different ways of enacting knowledge: recontextualizing, applying an analytical approach, and giving reasons. Hermansen and Mausethagen (2016), for example, emphasized

> …how abstract forms of knowledge require that teachers conduct significant 'translation work' for new knowledge resources to be experienced as relevant to established practice. (p. 93)

Hermansen and Mausethagen (2016) used the concept 'recontextualization' to capture this way of enacting knowledge. Hence, 'transforming' is one way of using or enacting knowledge as a (student) teacher.

However, knowledge can also be enacted in a more analytical and less action-oriented approach. As an example, this appears when a specific case or situation in school calls for deeper understanding. Here (student) teachers can invite and seek theories and/or experienced colleagues or experts to shed light on the case to qualify their professional practice.

A third way of enacting knowledge is to give reasons for the professional work, for example, when a teacher interprets the purpose of schooling through pedagogical values, approaches to humanity, ethical perspectives and other philosophical aspects.

In the literature Menter (2016) exemplified the last two ways of enacting knowledge. Menter presented four different conceptions of teaching identified in policy and research literature. Two of them, "the enquiring teacher" and "the reflective teacher," (Menter, 2016, p. 19) align with these two ways of enacting knowledge. The enquiring teacher "makes systematic enquiry into" teaching. The reflective teacher makes "considerations of the values underlying (teaching) and the purposes of education." In other words, the reflective teacher is also concerned with giving reasons for professional work.

We assume that further empirical research will identify more ways of enacting knowledge, but with these examples, we see the argument that enactment of knowledge is a specific way of handling knowledge, that is broader than just using, as saturated.

Subcategory 1C: Constructing knowledge

To some extent, the teacher also constructs or produces knowledge, and student teachers are educated in knowledge production, too (Menter, 2016). This is a third way of handling and approaching knowledge. The issue here is not whether the teacher also is a researcher, nor is it the question of quality in this knowledge construction. The point is to position the teacher as an agent in knowledge construction in combination with the other ways of handling and approaching knowledge. Menter (2016) used the concept of teachers' research skills. He claimed that "teachers should have the capacity and skills to engage in research themselves if the context and conditions are appropriate" (Menter, 2016, p. 20) and related this to his definition of professionality. Munthe and Rogne (2015, p. 23) emphasized using a model adapted from Healey and Jenkins (2009) that research-based teacher education is about student teachers' inquiry and their processes of knowledge construction.

Dimension 2: Modes of knowledge

With the second dimension of knowledge the focus shifts from the (student) teachers' way of handling knowledge to the different modes in which knowledge can appear. The question about the character of the knowledge worked with by (student) teachers is raised in various ways across the research literature (Ellis, 2016; Gilje, 2017; Raaen, 2018). The specific headlines suggested in Figure 1 draw on current categorizations made by Keiding and Qvortrup (2014) and Korthagen and Kessels (1999). It is important to stress that the categorization presented covers over deep, complicated and historical traditions and discussions concerning scientific theory - e.g. the concept of evidence and empirical truth (Quine, 1951), which are not explicitly addressed in this article.

Subcategory 2A: Global evidence

Global evidence refers to knowledge characterized by being empirical, systematic and generalized, hence decontextualized. Often it is also called educational research (Winch et al., 2015).

Ellis (2016) addressed both this subcategory and the one presented below (local 'evidence') in discussing the relationship between the profession and higher education institutions from a knowledge perspective. In the discussion, he defined one mode of knowledge which has "harder edges, are apparently more codifiable and probably more exchangeable for academic credibility and advancement" (Ellis, 2016, p. 368). So, the mode of knowledge that we call global evidence is often described as more 'scientific' and as

> …dominant in the natural and life sciences, engineering and medicine. These kinds of research are thought to be purer, more reliable, more certain and able to be confidently articulated. They emerge within the specialized activities of higher education and research institutions; they have academic status (Ellis, 2016, p. 368).

We agree with Ellis (2016) that global evidence often appears and follows the criteria described. But it is also important to stress that the knowledge dimension of global evidence can contain a broader perspective of empirical knowledge than described by Ellis, including empirical knowledge based on qualitative studies.

Subcategory 2B: Local 'evidence'

Another kind of empirical knowledge, which is also very active in teacher practice, is the local and contextualized experience-based knowledge. This subcategory can have a systematic nature (e.g. local questionnaires) but is often unsystematic. It is typically constituted as embodied knowledge, also known as tacit knowledge. Ellis (2016) referred to this subcategory as another kind of empirical knowledge. Following the discussion referred to above, he stated: "The other forms[3] of knowledge are often more local and contextual". The balance between global and local evidence was also referred to by Hermansen and Mausethagen (2016, p. 92), who stated that "generic forms of knowledge represent a contrast to the contextual and experience-based knowledge."

Following these arguments, it is relevant to differentiate between globally-oriented and generalized empirically-based knowledge on the one hand and more locally-based empirical knowledge, local 'evidence,' on the other. In relation to teacher education and teachers' professional practice the main point is not whether one of these modes of knowledge is 'stronger' than the other. The point is, as we see it, that a (student) teacher needs to be

[3] We do not use 'form' of knowledge like Ellis, but 'mode'. Forms of knowledge in our understanding refer to the artifacts and media in which knowledge are embedded: literature, speech, video, the body, etc. More in perspectives.

able to draw on both types of empirical knowledge and that the *enactment* and *construction* of knowledge at a school or a teacher education campus, everything else being equal, would be qualified if this choice of relevant knowledge approach(es) is done *consciously*. The matrix in Figure 1 can be used to emphasize this crossfield between modes of knowledge and ways of handling knowledge.

Subcategory 2C: Theory and philosophy

In opposition to 2A and 2B, the subcategory 'theory and philosophy' appears as global concepts, models, systematic reflections and systems of thoughts. It can more or less draw on empirical studies, but the categorical point in this context is that it appears or is communicated as theory: systems of concepts, models, etc. In this sense, the division of this subcategory from global knowledge correlates with the different kinds of episteme discussed by Aristotle, where empirical research is typically observing a phenomenon from the outside and at a distance, while 'theoria' is about studying a phenomenon from inside (Knudsen 2012, p. 57) (more about Aristotle below).

As an example, Winch et al. (2015) adopted a multidimensional approach to knowledge in an analysis of the potential of educational research for teaching. In their argumentation, they draw on both categories 2A and 2B, but they also pointed out theory and philosophical knowledge as teacher knowledge. They claimed:

> Theoretical knowledge derived from empirical and conceptual research is apt for use in education through the development of pedagogies, curricula and forms of assessment. These, however, are incomplete if they are not integrated with experience and situational awareness" (Winch et al., 2015, p. 212).

They continued:

> …a body of theory is important in enabling teachers to discriminate autonomously between good sense and common sense; the professional teacher exercises discretion and judgment to evaluate educational research (Winch et al., 2015, p. 213).

Referring also to a range of other references (Smeby, 2008; Wiese & Hovdenak, 2017), we not only see the intention of adding 'theory and philosophy' as a separate mode of knowledge, but we also see the important point that theory and philosophy as something specific offer criteria on which the teacher can act: theory enables the teacher to judge between "good sense and common sense" (Winch et al., 2015).

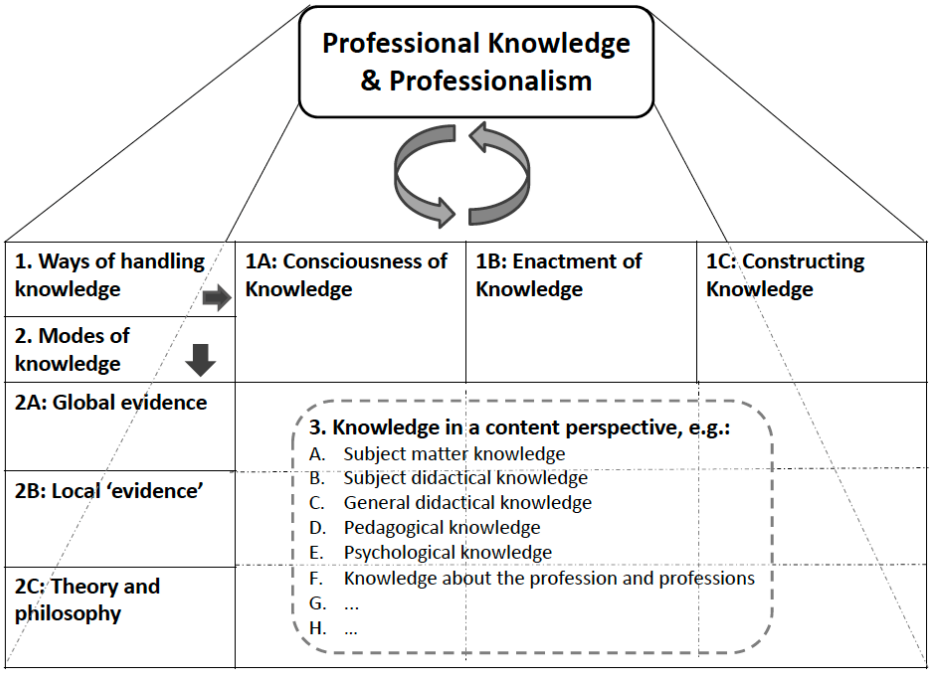
In relation to subcategory 2C, it is important to stress the non-hierarchical approach. In the end, it is the professional judgment carried out by the professional teacher that decides how and by which weight the different modes of knowledge are to be addressed in a concrete pedagogical situation. But as shown, this can hardly be done without addressing theory and philosophy. This said, we also recognize the many challenges connected to this ideal. For example, Danish studies show how both global evidence and basic professional knowledge are somehow marginalized in teacher practice (Lund,

2013). Additionally, international research highlights how student teachers can have very strong feelings, both negative and positive, toward working with 'theory and philosophy' (McGarr et al., 2017). Such beliefs of not needing theory to learn to teach can be strengthened when meeting the knowledge culture at a school. These facts indicate from our point of view how important it is to work explicitly with 'dimensions of knowledge' in both pre- and in-service teacher education and in cooperation across stakeholder groups.

Dimension 3: Knowledge in a content perspective

The two first dimensions concern the question about how knowledge can be approached and the overall character of various kinds of knowledge. But Figure 1 does not address 'the what question,' the content that will be part of a given teacher education program, and whether this content is organized as disciplinary subjects or in a more transdisciplinary way. This calls for a third dimension, illustrated as an overlay in Figure 2.

Figure 2: The typology illustrated with three dimensions: 'Knowledge in a content perspective' added in the foreground and teacher knowledge and professionalism in the background.



Ben-Peretz (2011) stated that the question about knowledge in relation to content arises from a subject- or discipline-divided approach to knowledge. Our point is that choices are made when organizing content in a teacher education program, even if this violates the organization of content in subjects. The question about 'knowledge in a content perspective' will be specific for each education. But there are some typical issues, e.g., education for a profession includes knowledge from more than one scientific discipline, and the

knowledge base is by its nature heterogenic (Grimen, 2008). Hence, it would be wide-ranging to include everything considered content across teacher education programs, but it appears that a 'rough' division between subjects and pedagogy is often used:

> A sub-question connected to this aspect of the knowledge problem is the question of the relationship between the teacher's knowledge of the subject being taught (sometimes called their 'subject knowledge') and their knowledge of teaching or pedagogy (Ellis, 2016, p. 367).

When searching the literature related to content and teacher education, it appears to be frequently discussed in research presenting the certain way of synthesizing subjects and pedagogy, PCK, elaborated below under professional knowledge. But the content in a typical teacher education program may be typified in more detail than just the division in subjects and pedagogy. In Figure 2 we exemplify the answer to 'the what question' in a list with: A) subject matter knowledge, B) subject didactical[4] knowledge, C) general didactical knowledge, D) pedagogical knowledge, E) psychological knowledge, and F) knowledge about the profession and professions. The incompleteness of the list is a key point. As emphasized by McGarr, O'Grady and Guilfoyle (2017), there is no agreed-upon body of knowledge within the international teacher education community, and it should also be repeated here that many teacher education programs include content organized in a transdisciplinary way, integrating aspects from the list. McGarr et al. (2017) discussed in particular 'theory,' stating that:

> ..the specific ways in which these areas are integrated, and what is defined as teachers' professional knowledge base, are often dependent on national factors influenced by statutory requirements and accreditation criteria. (p. 48).

So, the subcategories (3 A-F) could certainly have been listed differently and the list could have been longer, but nevertheless, the subcategories can be used to share and discuss what is done in a specific context. The content in teacher education is additionally organized very differently across programs, depending on whether it is post-graduate programs, where subject matter is addressed before the student teachers enter the program, as they have a degree in one or more subjects, or integrated programs like the Danish professional bachelor program or the Norwegian professional master program.

Summing up, we now have the three distinct dimensions: 1) Ways of handling knowledge, 2) Modes of knowledge, and 3) Knowledge in a content perspective (figure 2). It is important to stress that these dimensions and subcategories are analytical distinctions equal to each other, and (just) analytical distinctions. When using the dimensions in analysis of practice, all kinds of content, subject-specific or transdisciplinary, can in principle appear in the different modes and imply the different ways of approaching knowledge, and several of the sub-categories can be active at the same time so gray areas and overlaps appear.

[4] 'Didactical' in the continental tradition (the who, what, how and why in teaching), not the Anglo-Saxon tradition, where didactical describes a particular form of transmissive teaching.

Examples of analyzing teacher education with the three dimensions

We will now include a few examples of typifying approaches in teacher education before moving on to discussing professional knowledge, also added in Figure 2.

A first example could be a situation where student teachers in a campus-based lesson are introduced to the learning theory of Vygotsky, after having read an article as preparation. The mode of knowledge is theory and philosophy (2C), and the content perspective is psychological knowledge (3E). In the campus-based lesson, the teacher educator might give them the task of using the article to analyze a video showing a teaching situation in school: "Identify potentials and limitations in the theory of Vygotsky. Develop ideas of how the learning theory can inform the didactical planning of teaching." Here the student teachers are invited to handle knowledge in two ways: To be critical (1A) and to enact (1B). Another example could be a meeting between a group of student teachers and their supervisor at a placement school. The supervisor gives them advice: "Always have a 'plan B and C' when teaching math on Friday afternoon." Here the students meet local 'evidence' (2B), the content is related to the subject mathematics (3A) and the invitation to handle knowledge in this way would belong to category 1B.

So, the typology can be used to discuss 'what happens here,' but also to reflect on alternative approaches. When student teachers are working with a research paper from, e.g., mathematics education this will in many cases only be in the mode of global evidence (2A), and with the enactment of knowledge (3B) in the restricted understanding of 'using' knowledge. The content perspectives would be mathematics subject matter knowledge and subject didactical knowledge. But there might be reasons referring to the intended learning outcomes to include an inquiry task at a school with a broader range of modes of knowledge, ways of handling knowledge, e.g., constructing knowledge, and also other content perspectives, like 3F 'knowledge about the profession and professions.'

The typology can, in the way exemplified here, be used as a reflective and analytical tool when teacher educators together with student teachers and placement teachers are planning the teaching. In the last section, we discuss this in a more generic sense ('thinking technology'), but first we return to the question about 'professional knowledge'.

Professional knowledge, professionalism and PCK

The decision to represent professional knowledge in the background (Figure 2) was made along the process. It is not to imply less importance than the three dimensions – actually the opposite. The way we think about professional knowledge and professionalism is infiltrating the way we have constructed the dimensions, though setting out to be rather descriptive. Furthermore, we have experienced that the model, as it was taking form, inspired our discussions about professional knowledge and professionalism. Hence the double arrows.

Many different terms are used in reference to professional knowledge, e.g., practical knowledge, knowledge in practice and professional knowing (Edwards & Daniels, 2012; Hermansen & Mausethagen, 2016; Shalem & Slonimsky, 2014). There are differences; for example, the term 'knowing' implies knowledge in a specific context. Likewise, terms like 'professional vision' and 'professional judgment' accentuate the situated character of teacher knowledge. Professional vision furthermore implies the mediated and distributed character as it is often used discussing teachers' reflections mediated by video-representations, i.e., in the reference about reasoning here:

> Teachers' professional vision includes the ability to apply general pedagogical knowledge about components of effective teaching and learning to reason about significant features of classroom practice (Stürmer, Könings & Seidel, 2013)

So professional vision and professional judgment (Grimen & Molander 2008) are about the enactment (and reflection) of knowledge in a professional situation, with knowledge influenced by values and beliefs (Southerland et al., 2001). Max van Manen (2015), inspired by Herbart (1802), referred to teachers' ability to act with tact in a concrete situation, not as an instrumental 'doing,' but as an enactment reflected by pedagogical theory and including normative and affective aspects. Hence, the double arrows in the model illustrate the processes whereby the ways of handling knowledge are constituted as a concept of professional knowledge and at the same time inform the practice of enacting knowledge, also a process of developing professionalism.

'Professionalism' is an inherently normative concept used in slightly different research contexts than professional knowledge; for example, Carr (2014) referred to professionalism in arguing about the ethical nature and status that distinguish professions from other occupations. He emphasized that professionalism, as constituted in a teacher's classroom management, is not just about techniques, it requires a "moral authority grounded in a deep 'phronetic' appreciation of the complexities of human association" (Carr, 2014, p. 25). He referred here to the classical concept of 'phronesis' from Aristotle. Aristotle typified different types of knowledge as 'intellectual virtues.' In particular, 'phronesis' is also referred to in contemporary research in the field of professional education (Gilje, 2017; Kinsella & Pitman 2012; Wiese & Hovdenak, 2017). Phronesis describes practical wisdom as the basis for professional choices. Phronesis is different from two of Aristotle's other intellectual virtues, episteme and techne. Briefly, episteme is universal de-contextualized knowledge, while techne describes context-dependent knowledge. Kinsella and Pitman (2012) referred, for example, to the generative possibility for using phronesis in reconsidering the professional knowledge of practitioners in a time dominated by technical rationalities and instrumentalist approaches.

Professional teacher knowledge as PCK

As the last thing we will elaborate shortly on the particular conceptualization of teacher knowledge PCK, very frequently used in research addressing teacher knowledge. PCK addresses teacher knowledge as a transformation of content into pedagogically powerful forms (Shulman, 1986). The three domains of subject matter knowledge, pedagogical knowledge, and knowledge about context are often illustrated in a Venn diagram with PCK as the synthesis (Grossman, 1990). Hence, with PCK teacher knowledge is addressed from a content perspective (Dimension 3) and less through the lens of professionalism (Segall, 2004). PCK has been used in reference to various subject disciplines, for example, mathematics PCK (e.g., Kleickmann et al., 2013) and literacy PCK (e.g., Love, 2009); however, it is most widespread in science education. A range of researchers have contributed with conceptualizations of PCK in science education, latest illustrated in the so-called consensus model (Gess-Newsome, 2015), followed by the revised consensus model (Carlson & Daehler, 2019).

These PCK consensus models are excellent examples of the wide range of perspectives and issues discussed under the headline of teacher knowledge. The consensus model (Gess-Newsome, 2015, p.31) differs between a range of general and topic-specific professional knowledge bases referred to as public decontextualized knowledge, the opposite of PCK as private and contextualized knowledge. PCK was, with this model, viewed as something new compared to older PCK research, clearly illustrated as situated in concrete practice. This discussion raises some of the same issues as we do above concerning differing modes of knowledge. The teachers' knowledge bases are mainly described by Gess-Newsome (2015) as global evidence and theory/philosophy, but what we call local 'evidence' is emphasized when discussing the sources of development of PCK, including the importance of beliefs as amplifiers and filters. The revised consensus model (Carlson & Daehler, 2019, p. 83) is a very different kind of representation, though some of the same researchers were involved. Enacted PCK is placed in the center of this concentric layered model, illustrated as 'plan, teach, reflect' iterations (Carlson & Daehler, 2019). Furthermore, cooperation with colleagues is addressed in the revised consensus model referring to collective PCK. This is opposite to the first consensus model (Gess-Newsome, 2015), illustrating (only) individual teacher knowledge.

The key issue here is that the conceptualization PCK has mainly been used to analyze what teachers know or what knowledge they develop through specific projects. Opposite to this, the model of teacher knowledge proposed by Menter (2016) and referred to in the introduction addresses, in particular, the normative discussion about what a teacher *should* know to be able to act as a professional acknowledging 21st century challenges. The typology suggested in the present paper approaches the issue about teacher knowledge from quite another angle, e.g. going into more detail with the dimensions and subcategories of knowledge that are expected to be integrated into the center of the model from Menter (2016). Despite these different perspectives, some of the same puzzles and

dilemmas as addressed with the typology are raised through the history of the PCK research. Our aim is not to challenge the PCK models, the model from Menter (2016) or other models of teacher knowledge. The intention with the typology is not to analyze in details the knowledge in a content perspective developed by teachers participating in a specific project like that of e.g. the PCK research, but rather to stimulate discussions among the stakeholders in teacher education about the various dimensions of teacher knowledge, and the consequences taken as in the examples above.

Looking forward: The model used as a thinking technology

Summing up, knowledge in teacher education appears as a very complex and multifaceted phenomenon. Given this fact communication between different stakeholders calls for clarification of what the communication is about and not about before identifying agreements and/or disagreements.

The theme is not only complex but also hard to capture because it connects to other fundamental questions. The question about knowledge is closely connected to assumptions and fundamental considerations of the purpose and function of teacher education. Behind implementation of a given program lie as mentioned above different paradigms more or less explicated. Paradigms give different answers to the purpose of teacher education, the character of the nexus between education and practice in school and also to the question of professionalism. Puustinen et al. (2018, p. 171) emphasized these complicated connections to other basic questions, referring e.g. to the four paradigms of teacher education from Zeichner (1983). Our focus has been the clarifying work related to teacher knowledge in particular. We will, however, make an appeal to also address these other fundamental questions that are woven into the question about knowledge in professional discussions about teacher education.

We suggest that the typology can be used as a kind of ‘thinking technology’ (Lykke et al., 2000) when stakeholders have dialogues about teacher education and teacher knowledge. A thinking technology can be understood as a mediating tool which supports questions being raised systematically, but does not provide the answers. It is the users that construct the answers. We expect that the model also can be used in research, e.g., in the TEQ21 project, as a way of raising questions to the empirical material.

We present the typology, inviting further elaboration from colleagues in the field. One question that should be pursued is whether it catches the relevant perspectives and dimensions. It might, for example, be relevant to add another category about ‘forms of knowledge.’ By forms, we mean the media or artifacts that ‘carry’ the knowledge, whether it is theoretical, empirical, local or global. Knowledge can, for example, be carried through speech, as text in different kinds of literature, on video, tacitly embodied, etc. We think this dimension of how different categories of knowledge are mediated is of great importance and relevance. This has been touched upon briefly in the discussion and is also implicitly raised in the literature, e.g., when Edwards and Daniels (2012) referred

to artifacts being invested with culturally specific meanings. However, since this dimension has not been central in the focused searches in the literature, and because a fourth dimension in the typology may produce more confusion than clarification at the present point, we merely mention this as a possible elaboration going forward.

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