Dimensions of teachers' transdisciplinary competence based on a systematic review of three transdisciplinary areas

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Abstract

This study contributes to the conceptualisation of teachers' competence through a systematic review (a concept synthesis) of three key transdisciplinary competencies—teachers' diversity competence, teachers' research and development competence, and teachers' digital competence. Based on our analysis, we propose a set of dimensions to consider—within which there were important tensions in the research literature reviewed—when discussing teachers' professional competence. These dimensions are: the 1) beneficiary, 2) teachers' role, 3) attitudes, knowledge and skills, 4) sources of competence, 5) relationship to disciplinary content and 6) assessment. We discuss the three areas in light of these dimensions. We suggest that the complexity of being and becoming a teacher is a blind spot in research on teachers' transdisciplinary competence and that many articles show deficit thinking about teachers.

Keywords: teacher competence; transdisciplinarity; diversity competence; research competence; digital competence

Introduction and research questions

Three important features of powerful teacher education programmes are a common vision, coherence, and a strong curriculum grounded in practice (Hammerness, 2013). Teacher education programmes are situated in two learning contexts—on the one hand, subject area and pedagogical coursework and, on the other hand, clinical experiences—and as noted by Bulterman-Bos, "the way in which researchers view education differs fundamentally from the way in which teachers view education" (2008, p. 412). This difference can contribute to fragmentation and a lack of coherence. The distance between

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these two contexts is often described as a *gap*. In addition, teachers of different subjects may have a subject-specific vision. This may lead to a fragmented, less coherent curriculum and a weak scientific core (Hammerness, 2013).

Transdisciplinary areas of common interest for all teachers, such as diversity, research and development and technology, could reduce fragmentation and narrow the gap, thus increasing coherence, unless these areas themselves are fragmented and incoherent, both individually and when seen as a whole. Therefore, studying more than one transdisciplinary area at a time is necessary to discuss the fragmentation of teacher education programmes. Given that transdisciplinary competence may strengthen coherence, we see the need for a deeper understanding of how the research literature conceptualises transdisciplinary competencies.

Based on the above, the research question here is as follows: "What can the individual transdisciplinary areas tell us about teachers' transdisciplinary competence in general?" Put differently, "how can teachers' transdisciplinary competence be conceptualised?" We will approach this question by investigating the literature's conceptualisations of teachers' competence in three transdisciplinary areas: teachers' diversity competence (tDIVc), teachers' research and development competence (tR&Dc), and teachers' digital competence (tDIGc).

Teachers' professional competence can be defined as professional practice based on a knowledge base that enables the handling of complex issues related to learning and teaching (Lund et al., 2015). This knowledge base is likely to include elements from a variety of areas, including practical experience. The present systematic review is part of a larger research project[2] on teachers' qualification for the 21st century that focuses on the same three transdisciplinary competencies.

We chose these areas for several reasons. Most importantly, they are, potentially, sufficiently different to illuminate teachers' professional competence in different ways. Locally, the new Norwegian teacher education programme of 2017 paid particular attention to these three areas (amongst others) (Ministry of Education and Research, 2016). Internationally, all three areas have recently received considerable attention in both policy documents and research. tDIVc has attracted renewed interest because of the Salamanca Statement, in which United Nations Educational, Scientific and Cultural Organization endorses the idea of inclusive schools (UNESCO, 1994) and migration issues. tR&Dc is key to the European Bologna Process on the quality of higher-education qualifications (Bologna Process, 2018) and in the Organisation for Economic Co-operation and Development's efforts to develop teacher quality (OECD, 2005). tDIGc is important because of the accelerating digitalisation of society and the responses to this process (UNESCO, 2008).

The term "competence" is defined in numerous ways in the field of education, as pointed out by Westera (2001) and Glaesser (2019), amongst others. However, we have

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[2] See https://teq21.oslomet.no/?page_id=9 for more information on the project.

chosen not to attempt defining the term at this stage, because in this project, we aim to explore the content of this term in the context of transdisciplinarity. We use Alvargonzález' (2011) notions as a point of departure regarding the term transdisciplinary. He argues that transdisciplinarity is "that which concerns transcending the disciplines, going across and through the different disciplines and beyond each individual discipline" (2011, p. 388). This leads us to the term "discipline", which refers to a body of knowledge that can be taught and learnt (Alvargonzález, 2011). One can argue that education as such does not meet the criteria of being a discipline, but it is a synthesis of numerous disciplines, such as sociology, psychology and different school subjects, to mention a few, that together constitute the field of education. Thus, to understand the complexity of education, we need to understand this interdisciplinarity. When using the term "teachers' transdisciplinary competence" (tTc) we refer to the competence teachers need that is not contained within a single discipline; it is a competence that goes beyond and across disciplines. Although no comprehensive list of these competencies exists (or can exist), there is no lack of examples; tDIVc, tR&Dc and tDIGc are just three.

Theoretical basis

The growing literature on tDIVc, tR&Dc and tDIGc and other transdisciplinary competencies is situated between *Bildung* and *Fachdidaktik*. Biesta (2019) argues that Bildung developed from "a clearly defined set of knowledge, ideas and values" (p. 24) to a focus on notions such as "self-determination, freedom, emancipation, autonomy, rationality and independence" (p. 26). Fachdidaktik (subject matter didactics) is a family of research fields concerned with the teaching of particular subjects. In the US tradition, similar interests are covered by the term "pedagogical content knowledge", an intersection of pedagogical knowledge and content knowledge (Shulman, 1986, 1987). tTc is more specific than Bildung but more general than Fachdidaktik, in that it reaches beyond specific school subjects.

When discussing teachers' competence and knowledge, it is useful to look to Bernstein's (1999) knowledge discourses. He distinguishes between a horizontal and a vertical discourse, arguing that different kinds of knowledge are realised in the two discourses. A horizontal discourse includes what is commonly referred to as everyday knowledge or common-sense knowledge. Open to all, it is a set of strategies organised locally in segments. Bernstein (1999) refers to this as a cultural relay in which knowledge and strategies are handed from one person to another within the community in which it exists. Bernstein (1999) describes the knowledge of the individual members of a group as the individual's repertoire, whereas the overall strategies and potential within the group are called the reservoir.

A vertical discourse includes more scientific, official and context-independent knowledge that to a larger degree is generalisable, exemplified by different school subjects. This discourse is divided into two knowledge structures: the hierarchic knowledge

structure and the horizontal knowledge structure. The hierarchic structure contains explicit, systematic and principal structures of a cumulative nature. The horizontal structure consists of a segmented series of specialised languages with their own criteria regarding the content, questions, problems, and so on; that are to be considered legitimate.

We want to conduct a systematic review in order to resist the tendency to include only researchers and perspectives that we are already familiar with. However, with the horizontal knowledge structure mentioned above, simultaneously being very clear about what we are looking for and being open to unfamiliar perspectives are challenging. For instance, whilst we use the term competence in this introduction, in our systematic review we do not want to exclude researchers who prefer to use the terms "skills", "experience" or "knowledge". In this field, different perspectives often involve different words. The best we can do is to include a wide range of words—to cast our net wide, so to speak— whilst we risk giving the appearance of a lack of consistency.

Whilst there exist systematic reviews on transdisciplinary competencies separately (e.g., Akuma & Callaghan, 2019; Hubbard, 2018; Krogh & Kvols, 2016; Leutwyler, 2014; Robinson & Young, 2019; Rosenberg & Koehler, 2015), we know of no other systematic review that includes several transdisciplinary competencies at once to conceptualise the concept teachers' transdisciplinary competence.

Methods

Systematic literature reviews follow "explicit, accountable rigorous research methods" (Gough et al., 2017, p. 2), including a transparent procedure for searching for and selecting research findings to include. Systematic reviews come in a plethora of forms. The work by Sutton et al. (2019) is an example of a systematic review of systematic reviews, sorting 48 distinct review types found in the literature into seven review "families". For instance, a meta-analysis, which combines quantitative data from different studies to calculate a combined effect size, belongs to the systematic review family, whereas a scoping review, which is a "preliminary assessment of the potential size and scope of available research literature" (Sutton et al., 2019, p. 210) belongs to the purpose-specific review family.

In our project, the aim is to harvest from the literature a rich variety of perspectives on each of the three exemplary areas and to examine tensions in order to discuss how tTc can be conceptualised in a well-rounded way. Therefore, we are more interested in articles' discussions of concepts than in their results. Using the typology from Sutton et al. (2019), our choice of review best fits the review type *concept synthesis*, which is a "synthesis method used to identify concepts, viewpoints or ideas [… that f]ocuses on identifying the defining attributes of the concepts" (Tricco et al., 2016).

Search strategies

The search was carried out in the Education Resources Information Center (ERIC), Education Source and Teacher Reference Centre databases, which are international databases covering research literature within the field of educational sciences. A search in the transdisciplinary database Web of Science was also performed to capture literature that is not indexed in the education databases. To identify research literature from Scandinavia, we conducted searches in Swepub, the Danish National Research Database, Norart and Idunn. These databases were chosen based on the language proficiency of the researchers. We decided on a multi-language approach using English, Norwegian[3], Danish and Swedish, as literature in this area is often published in local languages (e.g., Sivertsen, 2013). Based on the research question, our library specialists helped set up a complex search with three main elements using search words and keywords in each of the three areas. The first element was related to *teachers*, the second to *competence* and the third to *each of the three transdisciplinary areas*. We kept the first two elements stable for all three areas, with a few adjustments based on earlier searches. The exact searches were different for each database based on the functionality of each. For the international databases (ERIC, Education Source, Teacher Reference Center, Web of Science), only the years 2014–2019 were included based on the reasoning that important perspectives in earlier years would also be found in newer articles. Regarding tDIVc, we ended up limiting full-text reading to the years 2017–2019 because of the volume of included articles after screening. For Norart and Idunn, one combined search for all three areas was made. Given the limitations in the Idunn database, we had to perform the screening simultaneously with the search.

Here, we will only give some examples of the choices we made in building the searches. For details, please see the Appendix. The asterisk (*) is the wildcard symbol, so searching for pedagog* includes all words starting with "pedagog", such as pedagogy and pedagogue. In the *teachers* element, teacher* was the central search word, and we chose keywords based on "teacher" and "teachers". In the *competence* element, we included words such as competenc*, skill*, perform*, knowledge*, pedagog* and expert*. In the *diversity* element, we included a variety of general terms connected with diversity (such as divers*, inclus*, exclus* and equalit*) and terms connected with many particular diversity dimensions (such as ability, social class, multicultural*, sexual*, religious, ethnic*, racial*, gender* and cultural*). We did not include terms pointing to particular groups of people (such as immigrants, gays, women, poor and Sami) or diagnoses (such as ADHD and ASD) because knowing where to stop would be difficult. In the *R&D* element, using the word "research" alone would lead to innumerable hits, including articles about research *on* teacher competencies instead of teachers' research competence. Therefore, we only included articles in which research was near certain relevant words (such as innovation, conducting, based, informed, led and oriented). In the *digital* element, we

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[3] Both variants, bokmål and nynorsk.

included general terms such as ICT, digital*, technolog*, digitization and computer* but not particular technologies, such as iPads and interactive whiteboards, for the same reason as above.

We used proximity operators to increase the precision of the searches, reducing the amount of "noise". This simultaneously reduces the sensitivity of the searches, which meant that the probability of missing some articles of interest increased. We also included a small number of articles found through manual searches when we thought they would add valuable perspectives.

Exclusion criteria

We were interested in articles discussing tTc in the three areas. Therefore, we excluded purely descriptive articles and articles that did not discuss teachers' competence. We wished to focus on teachers who teach pupils in classrooms in what corresponds to compulsory education in Norway; therefore, we also excluded research in which the teachers in question were not mainly classroom teachers of grades 1–10 pupils (ages 6–16). Articles in the context of teacher education were not excluded when their discussions concerned the competencies teachers need. Moreover, articles not in English or a Scandinavian language, articles that were outside the set timeframe and texts that were not articles were excluded. However, we did not exclude articles based on the method used, as all approaches could lead to interesting new perspectives.

In the tDIGc review, we excluded articles about developing countries, as we expected the technological context to be a limitation. In the tDIGc and tDIVc reviews, the volume of articles was so great that we chose to exclude those articles that did not explicitly signal in the title or abstract that the competencies were discussed as opposed to just mentioned.

Selection of studies

Teams of four to six researchers for each of the areas reviewed titles and abstracts using the software Rayyan. In each area, the researchers independently reviewed the same 100 titles and abstracts. After a discussion to fine-tune the exclusion criteria, only one researcher reviewed each of the remaining articles and consulted others only when in doubt. The full texts of non-excluded studies were then reviewed for inclusion, again with one reviewer reading each text and consulting others only when in doubt.

The method chosen for a systematic review tends to be a compromise based on the research question and the resources available. In this project, the priority was to *cast a wide net* and to read many full-text articles to obtain a wealth of perspectives. We had to give the screening process lower priority and could not afford to have two readers read every abstract or full-text article.

Data extraction

For each of the areas, the teams decided on a way to collect information and categorise the perspectives found when analysing the texts. As this was a concept synthesis, the most important part was to extract what the texts' contributions were in terms of perspectives on tTc. However, we also recorded the aims, methods and findings of each text. We chose not to use the exact same method in all three areas for two reasons. First, the three areas had different timetables, which meant that we learnt along the way what was useful for further analyses. Second, the reading of abstracts within each area suggested important perspectives to look for.

Analysis

Based on the extracted information, the research teams discussed what themes emerging from the material were worth studying further. As a part of this process, we developed ad-hoc tables to help organise the material and see if these would help structure the themes from different texts and foreground tensions. For instance, in the tR&Dc area, we used a table with attitudes–knowledge–skills as rows and finding/understanding–using–producing as columns.[4] Through this reconfiguration of information, the tables helped the teams make conjectures about patterns and tensions in the material that we could explore further.

The discussions also brought to light differing interpretations within the teams, helping each member look at the texts in new ways. Each team included researchers from the fields of pedagogy and subject matter didactics; therefore, interpretations from diverse fields interacted, a process that is of interest when studying transdisciplinary competencies.

Three of the researchers in the study took part in all three areas. This helped us compare and contrast perspectives between the three areas, and over the months of full-text reading and analysis, we explored similarities and contrasts. We discussed preliminary ideas across the teams and thus gradually developed a list of dimensions of tTc. These dimensions emerged during the analysis. In the last phase of analysis, we brought the dimensions back to the three areas to discuss them in a new light and found new similarities and differences between areas, even whilst this article was being written.
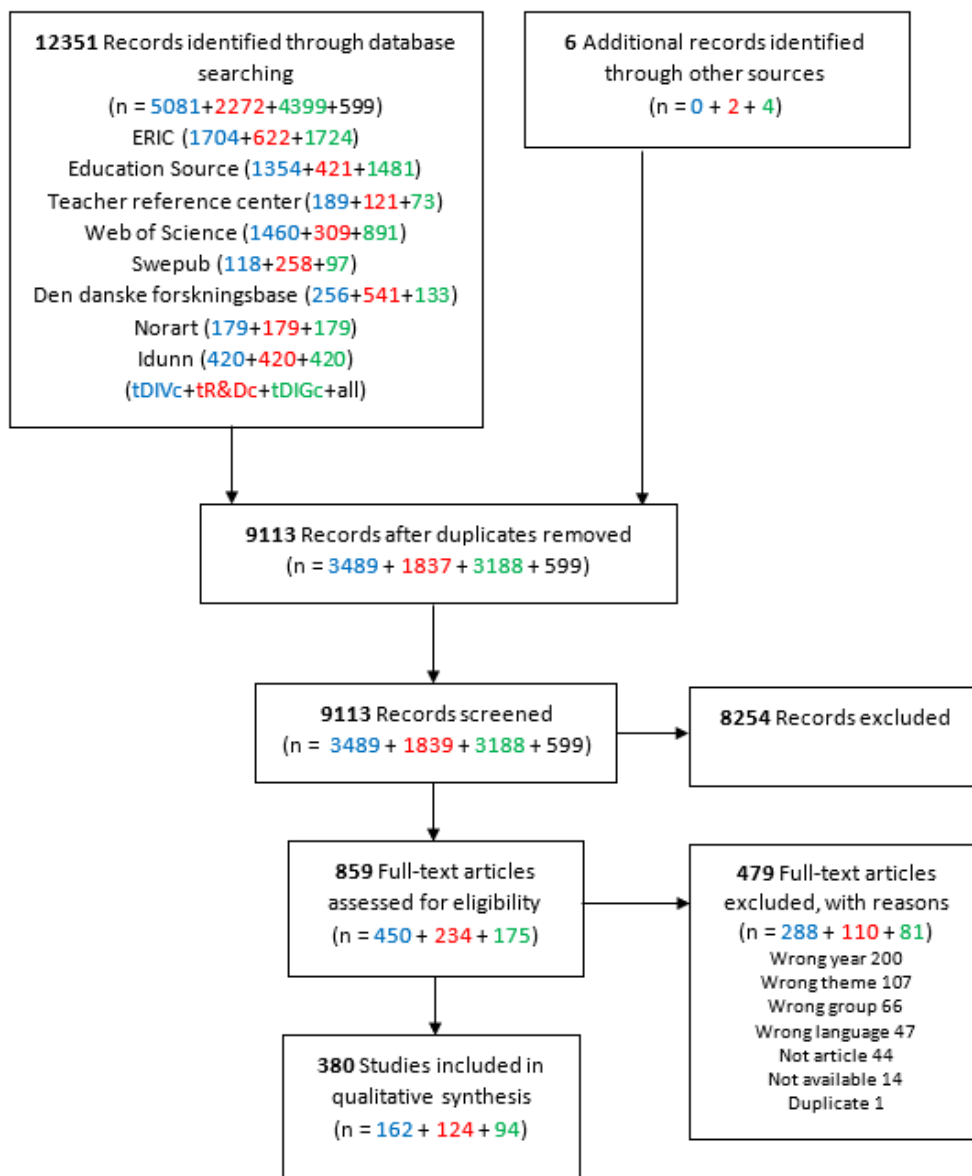
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[4] The division into attitudes–knowledge–skills seemed quite obvious because it was used in many articles, whereas the division into finding/understanding–using–producing appeared a bit later, based on many articles, for instance, van Schaik et al. (2018).

Results

Search results

We reviewed 9113 abstracts. Based on this, we included 859 articles for full-text review and ultimately included 380 articles. Please see the PRISMA diagram in Figure 1 for more details, including the numbers for the three areas.

Figure 1. PRISMA diagram

Blue numbers are related to the tDIVc; red numbers to the tR&Dc; green numbers to the tDIGc; black numbers are related to all three. For more details on the PRISMA diagrams, see Moher et al. (2009).

Dimensions of teachers' transdisciplinary competence (tTc)

In the articles studied, the individual transdisciplinary areas are rarely framed in a discussion of overarching teacher competence. However, in this section, we will zoom out to give a general picture. Based on our analysis of the three areas, we identified six key dimensions within which there were tensions in the literature reviewed. In using the word "tension", we refer to significantly different standpoints in the literature in which the resulting tensions will likely affect the conception of tTc. This is not to say that the different standpoints are necessarily theoretically incompatible but just that they are often not combined in our material. These dimensions are the 1) beneficiary, 2) teachers' role, 3) attitudes, knowledge and skills, 4) sources of competence, 5) relationship to disciplinary content and 6) assessment. After detailing these dimensions, we will discuss the three areas and then compare them in light of the dimensions. For the sake of space and readability, we only rarely reference articles that exemplify our findings.

Dimension 1: Beneficiary

Who is to benefit from tTc? We have found a tension between focusing on the welfare or learning of an individual student and focusing on the target group, which is the whole class, the whole school or society. Another aspect of this dimension is whether the students' context, their fellow students, their home and family, their culture and religion and their attitudes are considered.

Dimension 2: Teachers' role

Teachers' role may influence how tTc is discussed in several ways. Some see the teacher as a *functionary* implementing a method or policy from the outside or taking part in changes that others have initiated. Others see the teacher as creatively designing new learning situations. Still others see the teacher in a leadership role in change work in schools. The competence needed will depend on the role assigned to the teacher.

Some study a teacher's professional competence (and its development) in isolation, whereas others study it within a larger context. For instance, some use questionnaires with only information about one teacher at a time, whereas others study teachers' competence in light of the school discourse.

A teacher's work can be seen as mainly individual work or mainly teamwork. Collaboration with other teachers, special education specialists, parents or assistants is central in many articles, which means that collaboration skills are an important part of competence and that a teacher's skills must complement the skills of collaborators. In other articles, collaboration is not a theme.

The degree of specialisation is yet another part of this dimension. One extreme position would be to describe a package of competencies that all teachers need. Another extreme would be to argue that every teacher will necessarily have different competencies, which means that the right mix of competencies in a school is what is important.

Dimension 3: Attitudes, knowledge and skills

The studies included a focus on different components of teachers' competence in terms of knowledge forms—teachers' attitudes, knowledge and skills. Many articles focus on one of the three, typically teachers' attitudes. These articles necessarily give a different picture compared with focusing on knowledge or skills. Other articles include all three, and several investigate the correlations and causations between attitudes, knowledge and skills.

Often, self-efficacy is studied. As this is teachers' opinions about their own skills, it belongs in the attitudes, knowledge and skills dimension. Whilst emotions, such as fear, are also mentioned in a few articles, we choose not to include them here.

Dimension 4: Sources of competence

The central sources of teachers' competence are policy, theory, ethics, evidence and societal norms. tTc should enable the teacher to act in accordance with policies, theories, ethical considerations and evidence, but these sources are not always in alignment. Articles have different views on what to base tTc on when sources are incompatible. However, when the sources are in alignment, they are not discussed as much.

One particularly frequent tension is between research results from other contexts and the context-specific local knowledge of teachers. In parts of the literature, teachers' descriptions of the local situation are categorised as attitudes by the researchers.

Dimension 5: Relationship to disciplinary content

The disciplinary subjects have a central place in school and teachers' consciousness. In the reviewed literature, there seem to be three main approaches to disciplinary subjects. Some researchers situate the discussion of tTc within the subjects. Most of the articles, on the contrary, do not mention disciplinary subjects at all. The last approach is to conclude that the teachers' attitude towards their subject is a factor in how they regard transdisciplinarity. For instance, several researchers criticise teachers for downplaying transdisciplinary goals because they do not *fit* their subject. Some teachers value their subjects' neutrality and universality and feel that this is threatened if they have to include other perspectives.

Dimension 6: Assessment

The last dimension is about how tTc can be determined. There is tension between tTc as something that can be measured by self-reported self-efficacy and looking at tTc as something that can only fully be assessed by observing a teacher in a classroom setting.

Another aspect of this question is whether parts of tTc can be well represented by simple models or whether teachers' competence is too complex for simple models and must be looked at inductively based on the teacher in question. There is also tension between describing the competence that teachers ought to have and investigating the competence some teachers actually have.

Next, we discuss the three exemplary areas. In this format, we will not be able to give

fine-grained analyses but must be content with providing some of the main tensions seen. Whilst our discussion of tDIVc is organised according to the dimensions, tR&Dc and tDIGc have some other characteristics we want to highlight by organising these discussions differently.

Teachers' diversity competence (tDIVc)

The articles in the tDIVc area discuss diversity based on, for instance, language, religion, ethnicity, functionality, gender identity, culture, social class and medical diagnoses. In addition, several articles discuss diversity in general terms, either by including several diversity parameters at once or by discussing diversity without labels. In our discussion, we do not foreground the diversity parameters but try to integrate perspectives from the different articles.

One major tension in the literature concerns the beneficiaries; tDIVc can be connected with particular students who have specific characteristics or with the idea of diversity being an obvious feature of all groups. Within the first position, another tension concerns whether the individual or the group is the focus. On the one hand, tDIVc is seen as taking care of these individual students with specific characteristics (and adapting instruction to these students in class whilst providing good teaching to everyone), to the point of teachers visiting students' homes to learn about funds of knowledge that can be brought into teaching. On the other hand, tDIVc is seen as being about the teaching of diversity competence to students, regardless of the composition of the actual classroom. Moreover, there is tension between focusing on diversity between different groups versus focusing on diversity within groups, including how no one is a representative of only one group.

In tDIVc, teachers' role includes collaborating closely with several groups, for instance special education specialists, assistants and mother-tongue specialists. The home, family and culture of the students are also important. Thus, collaboration skills, willingness to improve one's competence, participating in group settings and being open to looking critically at one's own attitudes are considered important prerequisites for tDIVc in much of the literature. However, some articles consider teachers' competence in working alone with students in their classroom.

Another tension concerning teachers' role is whether there exists a sum of diversity competencies that all teachers need or whether each teacher's diversity competence will necessarily be different based on their own culture, language skills, experiences and other factors. There is also tension concerning whether knowing the students' context is so important that the teacher should preferably have the same background as the student.

Within tDIVc, a plethora of attitudes, knowledge and skills are pointed out. Whilst some researchers focus on attitudes, arguing that they are prerequisites for tDIVc, others focus on skills, arguing that good intentions alone are not enough. When discussing attitudes, there is a consensus that teachers need to believe in all students' abilities and that teachers should support inclusion and value diversity. Many authors find that teachers

exhibit deficit thinking about students, where teachers focus on students' lack of competence and its reasons and not on their achievements and resources.

Regarding knowledge, there is tension between acquiring knowledge about a particular group of students and acquiring knowledge about a particular student. Knowledge about a group may include symptoms (of different diagnoses) or the culture and history of the group, whereas a particular student may not fit the general pattern. Quite apart from this, some articles are more concerned about teachers' knowledge of the mechanisms of racism or exclusion in society than about knowledge of particular groups. There is a tendency in tDIVc articles to expect pre-service teachers to acquire quite detailed knowledge on medical conditions, culture, religion and other topics. Whilst each article may make sense, in total the expectations build up to form a tension between what is desirable and what is feasible. Regarding skills, there is tension between researchers arguing that teachers need to know specific strategies to use with different groups of students and researchers arguing for learning a variety of general strategies that can be tried in particular cases.

The view of tDIVc that emerges from the reviewed articles is full of tensions between different sources of competence: policy, theory, ethics, evidence and norms. For instance, inclusion seems to be the policy everywhere and is considered an important basis for tDIVc; but tDIVc is also influenced by local knowledge of what works in the classroom, which may be contrary to policy. However, the ethical imperative of combating racism is regarded as an important part of tDIVc, even when it is in contrast with apparently racist policies. Moreover, a policy to discuss heteronormativity with students may face resistance based on local societal norms.

One major tension in the tDIVc literature concerns researchers' interpretation of teachers' resistance. One interpretation is that teachers' resistance is founded mainly on local knowledge, including their knowledge of the particular context, pupils, parents and colleagues. For instance, Oranje and Smith (2018) argue that teachers' positive attitudes towards inclusion in theory were not translated into action, apparently because the theoretical perspectives were overshadowed by the local knowledge indicating that inclusion was difficult to achieve in practice. Another interpretation holds that teachers' resistance is an issue of unhelpful attitudes. In the first interpretation, the gap between researchers' intentions and teachers' local knowledge can be read in terms of idealism and realism or that researchers' attitudes are insufficiently grounded in local, contextual knowledge.

We would like to stay with this point for a moment. Most researchers are specialists in their areas, whereas teachers need to weigh different goals. We suggest that the area of tDIVc has a *blind spot* when it comes to the complexity of being a teacher. The vast range of responsibilities teachers are expected to take on is rarely mentioned in the articles.

Many articles uphold that tDIVc is learnt most effectively by exposure to diverse classrooms and different cultures. This finding is in contrast with those of articles arguing that tDIVc has an essential theoretical basis.

Diversity is connected with disciplinary content in predictable ways: language diversity to language subjects and functional diversity and disabilities to physical education.

In other cases, teachers resist working on particular transdisciplinary issues, as there is no "natural fit" with their subject. Teachers' attitudes towards their subjects are sometimes seen as excuses by researchers.

Numerous instruments to assess aspects of tDIVc are each seen one or a few times in our material, suggesting that researchers view parts of tDIVc as suitable for measurement by questionnaire. Yet, many articles are explicitly opposed to a test culture and discuss teachers' competence based on interviews and observations.

Teachers' research and development competence (tR&Dc)

One major tension in the literature is teachers' different roles concerning R&D. At one end of the spectrum, teachers are receiving R&D results from the outside and implementing them in their school. At the other end, teachers are actively producing and publishing R&D results. Another position is represented by a teacher who uses research to better understand what goes on in the school and who critically considers what might be good actions to take based on that. Still, others use R&D results strategically (van Schaik et al., 2018) as arguments in discussions with colleagues, school leadership, and others.

Connected with these positionings, in parts of the literature R&D is seen as a tool of democratisation, providing critical perspectives on teachers' situation and discursive practices and encouraging teachers to develop a more inquiry-based practice. In other parts of the literature, R&D is seen as giving teachers guidelines for practice.

We see tensions between the literature coming from a school context and the literature coming from a teacher education context. In the school context, teachers are more often seen as collaborative, whereas in the teacher education context, pre-service teachers are more often considered as individuals with individual R&D skills. Perhaps because of this, teacher education programmes often seem to focus on traditional academic research methods course contents, whereas school-based articles are more often concerned with teachers' attitudes and willingness to take part in research and teachers' role in research.

Some articles imply that teachers need the same knowledge and skills as any other researcher. Others argue that teacher research should be an area of its own with separate standards, publication forms and so on. Some argue that the goal is, after all, not to become mere knowledge producers but to become critical professionals.

We also see this tension in what counts as valid sources of competence. R&D can be seen to provide insights that can be combined with the local, contextual knowledge that is transferred informally between teachers. However, much of the literature is concerned with how teachers should develop their R&D knowledge and not how it can be integrated into their existing knowledge. In this sense, we can see signs of a kind of deficit thinking in which researchers are more concerned about what teachers do not have (research competence) than about what they do have (local, contextual knowledge).

The importance of tR&Dc is underscored by international trends (the Bologna Process), by national policies about teacher qualification and how research in universities

should include practitioners and by schools' local strategies. However, there are potential tensions here that are rarely discussed in the literature—whether teachers' interests are necessarily the same as university researchers' interests or the interests of the school principals who agree to take part. An apparent alignment of interests can hide underlying tensions between different stakeholders.

Surprisingly, the ethical issues in R&D work seem to be less in focus than the more practical issues. In addition, the discussion of whom R&D should eventually benefit is not often raised. Whenever teachers conduct research to benefit both their actual students and the educational community at large, possible tensions may arise.

The connection between the tR&Dc literature studied and disciplinary content is weak. Much of the literature does not go into detail on how R&D concerns the teaching of disciplines, and the fact that some school subjects include research methods as a part of what students should learn and teachers should teach is rarely included as one part of the reasons for teachers' development of their tR&Dc.

The tR&Dc literature studied does not seem to be very concerned with assessing whether teachers have particular R&D competencies. Examples of researcher and teacher collaboration are often presented with more details about what the researchers discovered about the students and the school than about what competence the teachers may have developed. There are some instruments for measuring tR&Dc, but they do not have a prominent place in the literature.

Teachers' digital competence (tDIGc)

The area of tDIGc stands out for its models. In particular, many articles refer to the influential Technological Pedagogical Content Knowledge (TPACK) model (Mishra & Koehler, 2006). This framework adds technological knowledge to Shulman's (1986, 1987) Pedagogical Content Knowledge model. Thus, TPACK includes technological, pedagogical and content knowledge, as well as all intercepts between two or three of these. At the centre of the model is TPACK, and a circle around the whole signifies the contexts.

Central tensions in the field are apparent in this model. As the model combines technological, pedagogical, content and contextual factors, there is almost unavoidable tension regarding which of the four is given the most attention at a given time. Even though content is one of the three inner circles in the TPACK model, TPACK research has been criticised for being too general and not including the specific needs of each discipline. For instance, for mathematics, Getenet (2017) proposes expanding TPACK with Ball et al.'s (2008) Mathematical Knowledge for Teaching model. Moreover, despite context being the largest circle in the TPACK model, it turns out that context is often not thematised in articles based on TPACK. When context is included, the factors of class and school are most often included, whereas teacher, student and societal factors are more rarely included (Rosenberg & Koehler, 2015).

Because of TPACK's dominant position in the literature, many other tensions in the area of tDIGc also materialise as discussions about TPACK and suggested tweaks to the model. TPACK is criticised for not including the important skills a teacher needs. Therefore, Yeh et al. (2014) propose the model TPACK-practical, with eight dimensions of practical use of technology. Staus et al. (2014) propose several teacher behaviours for the TPACK components at different levels that can be observed in practice.

Another related tension concerns how TPACK is assessed. The data source of choice is the questionnaire, which means that data about teachers' attitudes, knowledge and what they do (or what they are capable of doing) are, to a large degree, self-reported. Articles are rarely based on observations of teachers in the classroom. Because of the quantitative approach often used, researchers have also investigated the correlations between these self-reported measures.

In addition to TPACK and adjustments to it, many other models in this area differ from TPACK regarding the perspectives they emphasise. The Australian Institute for Teaching and School Leadership (AITSL) model, for instance, emphasises the teacher's role either as competently implementing teaching strategies that others have prepared or as collaborating with colleagues to improve teaching practice or even as a leader and supporter of colleagues. How we imagine the teacher's role will necessarily influence the tDIGc that we deem necessary. The Substitution, Augmentation, Modification, Redefinition (SAMR) Model (e.g., Hilton, 2016) concerns the role that the teacher believes technology can have. Similarly, the goal of teaching—for instance, whether a teacher's main goal is supposed to be to prepare students for standardised tests or to develop their 21st-century skills—influences the tDIGc needed.

Some models foreground other aspects, such as ethical issues, legal issues, a critical disposition and societal issues (the role of technology in the community). Other models attempt to be rather comprehensive; for instance, EU's DigCompEdu (Digital Competence Framework for Educators) model includes 22 competencies organised in six areas: professional engagement, digital resources, teaching and learning, assessment, empowering learners and facilitating learners' digital competence (Redecker, 2017).

Articles use both policy and theory as a foundation for the claim that technology is important. However, at times, teachers' empirical knowledge points to difficulties with practical issues such as classroom management and technology failing.

Discussion

The research question for this article was as follows: "How can teachers' transdisciplinary competence be conceptualised?" Based on our concept synthesis of the three key transdisciplinary areas, we proposed six dimensions of tTc as a part of the answer and claim that important tensions in tTc operate within these dimensions. Next, we discuss whether the dimensions illuminate important differences between the three areas. We also discuss

the overall picture of tTc that appears after reading the 380 articles from the three exemplary areas.

Comparing the three areas

tDIVc concerns students with legal and moral rights, which have a history of not being honoured. Therefore, it is to be expected that the individual student and groups of students are more foregrounded in this area than in the other two. tR&Dc is at the other end of the spectrum from tDIVc and is often not explicit about who is supposed to benefit from teachers' competence in the end. In tDIGc, it is clear that the beneficiaries are students, but students are mostly discussed as a whole rather than as individual students or groups of students.

At the same time, schooling also aims to change the world, and tDIVc is more explicit than the two other areas about that. tDIVc is meant to combat racism, homophobia and injustice. There is a greater sense of purpose and urgency within this area than in the two other areas. In tR&Dc, there seem to be two opposing views. In one view, tR&Dc is a force for democratisation and teachers' autonomy; in the other, it is a way to enforce evidence-based teaching and is a threat to local autonomy. In tDIGc, society is more often seen as something students should be prepared for than something students should be changing.

The teacher's role differs between the three areas. All three areas include the tension between the teacher as a functionary and the teacher as an inventor or leader. tDIVc again stands out for the broad range of collaborators involved—parents, special educators, assistants, local ethnic minority groups, and so on. In tR&Dc, collaboration most often occurs with other teachers or with researchers, whereas in tDIGc most of the research does not mention collaborators explicitly. In addition, tDIVc is more concerned with how all teachers are different, with their own cultures, languages and experiences, while the areas of tDIGc and tR&Dc rarely go into such differentiation between teachers.

The strong focus on attitudes is striking in all three areas. Attitudes towards diversity and inclusion, towards the use of technology and towards R&D, are often researched and are seen as barriers to be overcome. All three areas have some key preferred attitudes and some attitudes that seem impermissible. For instance, Aflalo (2014) states,

> It was further found that most teachers are convinced that meaningful learning can be attained without the need for computer technology. This position, together with the partial use of these technologies, exposes a rooted attitude according to which the teachers do not believe in the pedagogic advantages of computer technologies. (p. 120).

Similarly, given that teachers are supposed to become more reflective and autonomous by acquiring R&D knowledge, we wonder if there is a point at which they are "allowed" to reflect and autonomously decide that they have enough R&D knowledge and need more local, contextual knowledge.

The sources of competence work differently in the three areas. Whilst tDIGc and

tR&Dc find support in policies, this is more varied in the case of tDIVc. Some articles on tDIVc are explicitly subversive in that they attack the current policy or system for being racist, homophobic and so on. Others eagerly quote legal documents to support their cause. Obviously, there are also tensions between what policies ask for and what is deemed possible at the local level.

Whilst disciplinary content has a limited role in tR&Dc, in tDIGc, a relation to content is an integrated part of several models. tDIVc, on the other hand, is partly seen as particularly important in some subjects, whereas other subjects are partly seen as an obstacle to diversity work.

Finally, there is a clear difference in how competence is assessed. In tDIGc, most of the literature seems to agree that tDIGc can be measured. In tR&Dc, there are almost no such measurements, whereas tDIVc is in a middle position.

Therefore, we conclude that the dimensions help in making important differences and similarities between the areas visible. One question that we do not feel prepared to answer but still want to raise is whether these differences that we believe we found reflect concrete differences in the underlying concepts or whether such differences are unconscious biases based on who have been important researchers in the areas.

Returning to Bernstein (1999), it seems that tDIVc, can, on the one hand, exhibit a horizontal knowledge discourse. A substantial body of research deals with the kind of knowledge and strategies that teachers in one particular school area, such as in rural parts of Australia, need to be able to cater for students from indigenous families, and it argues that this knowledge and strategies are best acquired from the local reservoir and through experience. Collaboration skills are also frequently discussed. Said competencies can be looked upon as context-specific and context-dependent and not necessarily connected. On the other hand, one can argue that tDIVc also exhibits vertical knowledge discourses with horizontal knowledge structures. This is seen in, for instance, literature discussing teachers' competence regarding students with specific medical conditions and teachers' competence in mechanisms of racism. The two types of competencies consist of specialised languages that differ significantly from one another. The vertical knowledge discourse with horizontal knowledge structures is also seen in tR&Dc. In parts of the literature, tR&Dc is considered a tool of democratisation, providing critical perspectives on teachers' situations. In other parts of the literature, from the teacher education programmes, tR&Dc is more concerned with academic research methods course contents. The two perspectives from the literature utilize different specialised languages. Meanwhile, the models of tDIGc, particularly TPACK, provide a common language, making tDIGc somewhat more hierarchical. Many critics of TPACK suggest improvements rather than creating new languages.

Teachers' transdisciplinary competence (tTc)

The sum of attitudes, knowledge and skills that teachers need is overwhelming. The literature includes attitudes towards pupils, inclusion, technology, research, parents, colleagues and their own subject; knowledge of diagnoses, technologies, research methods and how society works; and skills in writing individualised education plans, teaching blind students and collaborating with parents. These are, of course, only examples.

It is feasible that teachers need some of these competencies from day one, whereas others can be developed over time or when needed. We rarely see such nuances in the literature reviewed. The question of when teachers should develop their competence also touches on Bernstein's (1999) concepts of horizontal discourse and vertical discourse. The knowledge developed over time will tend to be derived from practice, dependent on the context in which the phenomenon exists, and thus belongs to horizontal discourse, which may be regarded as less valuable by researchers.

A related issue is whether all teachers in a school need the same competence or whether it is in some cases better to view the school as a whole and consider the combined competence that can be mobilised when necessary. We could view the system's reservoir of knowledge, like Bernstein (1999), as the base on which a teacher can expand their repertoire over time. In that case, teachers need a repertoire to start with, and then the ability and willingness to expand the repertoire become central to tTc.

Given the total sum of considerations that teachers need to take into account, one key part of teachers' competence is judgment, which entails making on-the-spot decisions about the issues that need to be prioritised among the many important ones at the moment. This ability, whilst forming an important part of Biesta's (2014) theories, for instance, is rarely mentioned in the literature we reviewed. There is a certain taken-for-grantedness regarding the causality between teachers' attitudes and what they end up doing in the classroom. Although many studies show clear correlations between attitudes and skills, improving attitudes is not a panacea.

The tendency to define lists of competencies that all teachers need within an area and then test whether they have them is what we have called deficit thinking, drawing a parallel to the deficit thinking attributed to teachers in the literature. A more asset-focused approach that some researchers take is to study teachers' competence as it plays out in the classroom, being open to seeing competencies they do not expect.

One salient point is that the descriptions that teachers intend to be expressions of local knowledge based on their in-depth understanding of their complex context are interpreted by researchers as teachers' problematic attitudes. In an extreme example, teachers' statements are interpreted as a "camouflage" for attitudes (Mulholland & Salm, 2017, p. 85). Both teachers' and researchers' interpretations may be influenced by their attitudes, making researchers' interpretations of teachers' interpretations vulnerable to criticism.

In this article, we have looked at the tensions in how tTc is viewed in the literature. Some tensions can also be viewed as tensions within teachers and schools or as tensions

facing teachers. Given that we believe judgment is an important part of teachers' competence, we question whether studying teachers' transdisciplinary competencies one at a time, without consideration for what other priorities teachers may have, makes sense. Because of the complex nature of teachers' responsibilities, teachers make judgments all the time. Researchers, with their specialities and focused research questions, may interpret as lack of competence what is instead a judgment call to prioritise something else at the moment.

Strengths and limitations

The main strength of this review is its attempt to conceptualise teachers' professional competence by going in some depth into the literature on three important subareas. It is based on a huge number of articles to obtain a perspective-rich view of these subareas. In addition, the participation of several researchers from different fields helped bring subject-based preconceptions into the open.

Another strength is the inclusion of a variety of search words. Still, other choices could have given other results. It can be argued that "inquiry" should be included to give different perspectives than "research". However, even in our material, 149 of the downloaded full texts in tR&Dc included the word "inquiry". Similarly, "knowing" was not included in the search for competence, but 81 articles in the same search included it. Another strength is the inclusion of more languages than just English, even though the inclusion of major languages such as Mandarin or Spanish could have given even more diversity.

Because of the vast literature relevant to our subareas, we had to narrow the search in important ways, as we did not have the capacity to screen more than about 3000 articles per area. The searches are fully documented, so readers can look at our choices in detail. It is still important to keep in mind that other choices in building the searches would necessarily give other collections of articles to start with.

Even with the strategies for narrowing the searches, we could not prioritise having two or more researchers at all stages of the screening and full-text reading. Therefore, we can give no quantitative measure of the degree of agreement between reviewers. It is even likely that we may have missed important perspectives during the screening. Nonetheless, having the aim of the current project in mind, we believe it was more valuable to cast a wide net and relax the screening standards than to have strict screening standards but needing to narrow the searches further. As is always the case, different teams of researchers with different pre-conceptions might have ended up emphasising different aspects of the material.

Conclusions

Returning to the question of fragmentation or coherence in teacher education programmes, our review does not suggest that the work on transdisciplinary competencies

will necessarily reduce fragmentation or increase coherence, given that the areas we reviewed are full of tensions. We argue that as transdisciplinary competencies are essential components of teacher education programmes, they should be included in ways that make coherence possible. Perhaps the dimensions we presented could be a starting point for such work. We believe that the six dimensions of tTc can prove useful when discussing transdisciplinary areas and when designing new projects. Even if the goal is not to cover all aspects at once, they may highlight blind spots in the area. We argue that we have uncovered blind spots that need to be investigated more thoroughly, and that this could be a contribution to the process of developing more coherent teacher education programmes.

Winnie the Pooh was once asked, "Honey or condensed milk with your bread?" He replied, "Both" (Milne, 1926, p. 26). We agree with Pooh concerning all the tensions. Teachers need to take care of individual students *and* the whole class; implement programmes *and* be leaders; have attitudes, knowledge *and* skills; and follow policies *and* make ethical judgments. It is difficult to avoid the conclusion that the sum of competencies teachers need, according to the literature, is unrealistic. It would be tempting to end this article with a model of teachers' transdisciplinary competence that includes a plethora of aspects, in order to overwhelm readers. No teacher can have it all, just as not all teachers can know all subjects. Regardless of whether the teacher education programmes are one year or five years long, they need to prepare teachers to use judgment in situations they are not ready for and to make priorities, just like Pooh, who had his priorities clear when he added "but don't bother about the bread, please" (Milne, 1926, p. 26). Whilst this perspective is rarely found in the literature we reviewed, we believe that the issue of judgment and priorities on the spot needs to be stressed in teacher education and teacher education research. Although theory can have important consequences for what a teacher should do, acknowledging that a teacher cannot do everything at once may diminish the perceived gap.

Acknowledgements

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