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Martin Mulder

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## Agricultural pedagogical content knowledge (APCK)?

In my previous Editorial on workplace learning and competence development (see Volume 23, Issue 4), I gave an impression of the conference on that theme which took place in Bonn, Germany, in June 2017. The problematic discussed during that conference was positioned at the level of vocational education, so without specifying workplace learning and competence development for a specific vocational domain, such as agriculture, technology, care or administration, although many examples were given. That was fine for that conference, and there is a great need to reflect on the design of workplace learning trajectories in general to develop vocational, social and personal competence, but the question remains unanswered whether there is need for deepening this reflection by specifying it for vocational domains.

The question whether such a specification exists for the agricultural domain has haunted many agricultural education departments at universities, because the quest for the specific in vocational didactics in the agricultural domain appeared to be answered over and over again by stating domain-specific didactics for agriculture, like *Fachdidaktik*, which I see as pedagogy for a specific subject, did not exist. Questions I asked to colleagues in agricultural teacher education about what they were doing in the field of agricultural didactics appeared to be quite puzzling for them, like they were wondering: ‘What do you mean by that?’

For me, it was an obvious question, as in my first job as a curriculum developer of and lecturer in nursing teacher education, we had nursing-specific didactics, and one of my first articles as an education scientist was about that didactics field. While designing and implementing the teacher education programme, I quickly sensed that much in this branch of teacher education had to do with emotions and holism. Caring for patients draws upon quite different competencies than for instance plumbing. Patients with serious health problems are anxious and should be viewed as persons, not only be identified as numbers in rooms with their diseases, like ‘the leg in room 4’. Ethical dilemmas in this field are quite specific and far reaching, and can be a matter of life and death. So the attitudinal dimension in teacher professional development became an integrated part of the curriculum. Within modules we developed, or even in specific modules on nursing didactics and professional ethics, students were invited and challenged to reflect on domain-specific teaching and learning issues and ethical questions, by which they developed a better understanding of, and more advanced skills in these fields.

Even before my role in nursing teacher education it was already quite ‘normal’ for me to think about domain-specific didactics, as I had been studying the science-track of secondary education, and elementary teacher education with subject-specific fields of pedagogical content knowledge (PCK), where teachers of mathematics, physics and chemistry had specific methods and models to explain subject-specific knowledge, especially for complex constructs. I remember the hilarious first lesson in chemistry I took, taught by a chemistry teacher with Indonesian roots, who incidentally was an alumnus from Wageningen University. He held a glass test tube, dropped it in the sink on the demonstration desk in front of the classroom, and it obviously shattered into a thousand pieces. He then spoke the timeless words: ‘Glass is matter. Matters have properties’. Words I remember even after 36 years. This is of course a simple example, but there are many more in all kinds of science fields, like models of the

periodic system in chemistry, the solar system in astronomy and DNA in biology. Or take the Pythagorean Theorem in geometry. There are various ways of visualising  $c^2 = a^2 + b^2$  within a rectangular triangle, where  $c$  is the hypotenuse and  $a$  and  $b$  the other two sides. That visualisation is specific for geometry and therefore part of mathematics didactics.

Lately, I have been confirmed about the justness of raising the question about agricultural didactics in agricultural education. More and more publications appear on PCK, Technological Pedagogical Content Knowledge (TPCK) and also Technological Pedagogical Content Knowledge (TPACK). PCK is the combination of subject-specific knowledge and didactical knowledge, such as in mathematics didactics or biology didactics. When TPCK and TPACK are being used, the phrases stand for the combination of subject-matter knowledge, didactical knowledge and knowledge of technology. The term Content pedagogy was used by Darling-Hammond and Bransford in their 2005 publication titled 'Preparing teachers for a changing world: What teachers should learn and be able to do', published by Jossey-Bass. They distinguished knowledge of learners and their developments in social contexts, knowledge of subject matter and curriculum goals and knowledge of teaching, as key components of teaching as a profession. They used 'content pedagogy' within the category knowledge of teaching. PCK, TPCK and TPACK are recently getting increasing attention. See for instance the work of Koehler and Mishra of 2005 ('What Happens When Teachers Design Educational Technology? The Development of Technological Pedagogical Content Knowledge') in the *Journal of Educational Computing Research*, Volume 32, Issue 2, pages 131–152, Mishra and Koehler of 2006 ('Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge') in *Teachers College Record*, Volume 108, Issue 6, pages 1017–1054, or Koehler and Mishra of 2008 ('Introducing TPCK') in the *Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators* of the Committee on Innovation and Technology of the American Association of Career and Technical Education (pages 3–29, published in New York by Routledge). Or the work of Niess et al. of 2009 ('Mathematics Teacher TPACK Standards and Development Model') in *Contemporary Issues in Technology and Teacher Education*, Volume 9, Issue 1, pages 4–24. So we can rephrase the question in the beginning of the Editorial, regarding the existence of vocational didactics in the agricultural domain, using the concept of APCK. With APCK I mean the body of domain-specific knowledge about the design, implementation and evaluation of teaching and learning of agricultural theory and practice.

What can we learn from the German context about PCK, TPCK, TPACK and APCK? To answer this question, we have to understand that *Didaktik* (as didactics, or pedagogical knowledge) is a big thing in German educational science. This also holds for didactics in vocational education. Two types of use can be distinguished regarding didactics in vocational education: (1) *Didaktik* of vocational education; and (2) Subject didactics (*Fachdidaktik*). The second type of didactics is the type which is related to PCK with all its variations, including APCK.

Let me first say some things about vocational education didactics. That can be seen as a sectoral subset of educational research, and is related to questions about the alignment of work and education, the role, organisation, planning and assessment of workplace learning, the structure of the curriculum (for instance in learning fields), work-process knowledge, authentic assessment and vocational teacher education. In the German field of didactics, many theories, models and concepts are developed, which are described in a study text written by Nickolaus (*Didaktik – Modelle und Konzepte beruflicher Bildung*, Schneider Verlag, 2008). This text is part of the basic curriculum for vocational and economic pedagogy (*Berufs- und Wirtschaftspädagogik*). As you may know, German vocational education is typically divided into two corresponding realms: technology and economics. In this text, Nickolaus gives overviews of models of general didactics and vocational didactics. Models of general didactics are

divided by Kron into three groups in which different key concepts play a major role: (1) *Bildung* (often translated as ‘shaping’); (2) learning and learning processes; and (3) interaction. Major theorists cited in these groups are (1) Klafki; (2) Heimann, Otto and Schulz; and (3) Schäfer and Schaller, and Winkel. In total, Kron, in his review of didactics in Germany, distinguished 30 theories (see his work *Grundwissen Didaktik* of 2000).

Next, Nickolaus gives an overview of theories and models of vocational didactics. He goes into domain-specific theories first, and presents didactical theories of vocational education when he proceeds.

Regarding the domain-specific didactics, a whole series of Technical-Vocational Pedagogical Content Knowledge domains is mentioned. Amongst these are didactics for metal technology, electrical technology, calculus, construction, carpentry, economics and governance, nutrition and home economics, health care, health, cosmetics and political education. For some of these PCK domains-specific books have been published. Nickolaus mentions various works, and points at the overviews of the commercial-technical (*gewerblich-technischen*) domain, which is reviewed by Lipsmeier, and the economic domain (*Berufsfeld Wirtschaft*), in which various theories have been developed, which are mainly connected to the vocational pedagogical theories, such as the approaches of key qualifications (Mertens), anticipating didactics (Zabeck), didactics as decision theory (Achtenhagen) and labour-oriented exemplarism (*arbeitsorientierte Exemplarik*) (Lisop; Huisinga). The author does not elaborate the PCK domains, as that would go beyond the text. He confines himself to overviews of more generic vocational pedagogies. He however does present and discusses a selection of general didactical models, some of which are general didactical models, and others are vocational didactical models.

The didactical theories of vocational education are still quite general in nature, although they are related to vocational education. Examples of these didactical theories are the subject-science-oriented (*fachwissenschaftsorientierte*) approach (also referred to as approaches of didactical reduction), the shaping (*gestaltungsorientiert*) approach of Rauner, the concept of key qualifications (*Schlüsselqualifikationen*) of Mertens et al, the concept of activity orientation (*Handlungsorientierung*), in which vocational action competence (*Handlungskompetenz*) is viewed as the overarching goal of vocational education, and the concept of learning fields (*Lernfeldkonzept*).

What can we learn from this? Is there an ACPK domain? From the review of Nickolaus, one would say not really. But there is more. When I was visiting a colleague in Berlin some years ago, I noticed there was a chair for agricultural didactics, and one for horticulture didactics. When I searched on the internet for agricultural didactics, I found a list of courses for PCK domains, of which agricultural economics (*Agrarwirtschaft*) is one (taught at the Technical University in Munich, TUM). Other courses taught at TUM which are relevant in the context of this Editorial are PCK Life Sciences, PCK Biology, PCK Chemistry, PCK Electrical and Information Technology, PCK Mathematics, PCK Physics and PCK Megatronics. However, there seems to be very little research on ACPK, or we do not see it, which is a pity in either case. Research in the field of ACPK should have lots of potential. Maybe we do not see ACPK-research because it is compartmentalised in a whole series of domain-specific PCK’s in fields like biology education, chemistry education, economics education, engineering education, environmental education, ethics education, management education, mathematics education, physics education, research methodology education, statistics education, etc.

In the U.S., there seems to be a beginning to use the term PCK in agricultural education. See for instance the publication of Rice and Kitchel this year, titled ‘Teachers’ Beliefs About the Purpose of Agricultural Education and Its Influence on Their Pedagogical Content Knowledge’

in the *Journal of Agricultural Education*, Volume 58, Issue 2, pages 198–213 (<https://doi.org/10.5032/jae.2017.02198>; full text accessible for members of *The American Association for Agricultural Education, the AAAE*). However, PCK does not feature as a research priority in the research agenda of the AAAE ([http://aaaeonline.org/resources/Documents/AAAE\\_National\\_Research\\_Agenda\\_2016-2020.pdf](http://aaaeonline.org/resources/Documents/AAAE_National_Research_Agenda_2016-2020.pdf)).

So, what should we conclude? Two things, I would say.

First, in agricultural education more research can be done to develop APCK as the body of domain-specific knowledge about the design, implementation and evaluation of teaching and learning of agricultural theory and practice, since currently this knowledge is fragile and hardly visible. This research can be connected to the research on various PCKs of the subjects taught in agricultural education, some of which is published in journals which are within the Science Citation Index under the category Education, Scientific Disciplines (such as the *Journal of Nutrition Education and Behaviour*, or the journal *CBE-Life Sciences Education*), or within the Social Science Citation Index (such as the journal *Chemistry Education Research and Practice*, the *Journal of Research in Science Teaching*, the *Journal of Engineering Education*, *Advances in Health Sciences Education* or the *Journal of Environmental Education*). I think this is important as agricultural and environmental education are related to survival of the human species, the challenge to feed a growing global population, the natural environment, governmental issues, sustainability of production and consumption patterns, climate change, nutrition and health, ethical behaviour, animals welfare, etc. This unique combination of global issues calls for a unique kind of PCK, in which the development of declarative, conceptual, procedural and metacognitive knowledge is strongly anchored to the development of affective competence.

Second, research on the didactics of agricultural education can be linked to research on the didactics of vocational and professional education, which is published in journals such as *Vocations and Learning* (Springer) and the *Journal of Vocational Education and Training* (Taylor and Francis). Themes studied in these fields like learning and work tasks (*Lern- und Arbeitsaufgaben*, Howe and Gessler), entrepreneurship (Weber et al.), boundary crossing (Cremers), workplace learning (Nieuwenhuis et al.), multi-culturality (Popov et al.), first and second order argumentation (Noroozi) and multi-disciplinarity (Spelt et al.) are all relevant. But the *JAEE* obviously also published work which is relevant for the design and organisation of agricultural education and training. See for instance the contributions this year of Muthoni and Miiro on transfer of training, of Abbey, Dowsett and Sullivan on problem-based learning in horticulture, and of Ramesh, Reddy, Rao, Dhandapani, Siva and Ramakrishna on characteristics of faculty members (all in Volume 23, Issue 1). As Editor in chief of the *JAEE*, I would certainly like to receive more conceptual and research manuscripts on APCK and didactics of agricultural vocational and professional education. So your contributions in these fields are more than welcome.

Martin Mulder

*Editor-in-chief, Wageningen University, Wageningen, Netherlands*

 [martin.mulder@wur.nl](mailto:martin.mulder@wur.nl)  <http://orcid.org/0000-0002-8729-2477>