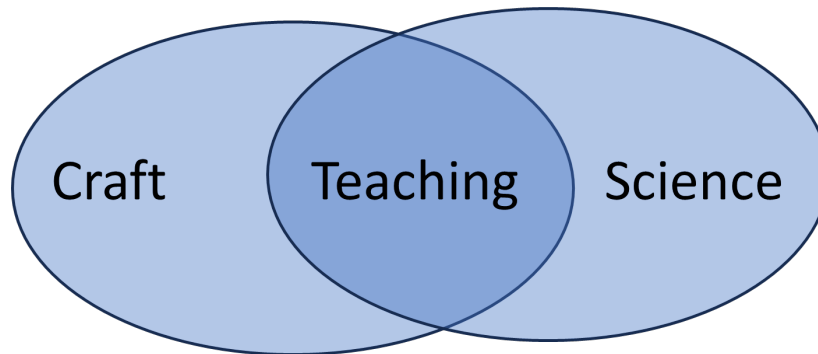


## Science and Craft: The Path to Competent Teaching



This article was originally published in TH&MA in Dutch as *Wetenschap en ambacht: De weg naar vakbekwam leraarschap*<sup>1</sup>.

**Good teacher education programmes ensure that their students are 'entry-level competent' by providing them with certain in-depth knowledge and skills. But that's not enough for the novice (i.e., beginning) teacher. Because what teaching actually is can only be learned in practice, intensive supervision in the first years is essential.**

Lee Shulman wrote in 1986: 'Those who can, do. Those who understand, teach'. Teaching is a unique combination of *craftsmanship and science*, one of the reasons why I always speak of 'evidence-informed' rather than 'evidence-based'. To start with craftsmanship, Jan van Driel, Nico Verloop and Wobbe de Vos introduced the term *teacher craft knowledge* in 1998. They defined it as "integrated knowledge which represents teachers' accumulated wisdom concerning their teaching practice. As this knowledge guides the teachers' actions in practice, it encompasses teachers' knowledge and beliefs concerning various aspects such as pedagogy, students, subject matter, and the curriculum" (p. 674). Shulman (1987, p. 8) calls it "that special blend of content and pedagogy that is unique to teachers, their own special form of professional understanding".

This is not the same as what we usually understand by the term '*pedagogical content knowledge*' (PCK), where you learn how a particular subject is best taught with subject-specific teaching tools. Pedagogical content knowledge, as seen by Van Driel and colleagues, is a specific part of the teachers' craft in which subject-specific knowledge is transformed in such a way that it can be effectively and flexibly transferred in the classroom. PCK is, according to them:

1. the result of analysing problems they have faced in their classes; and
2. knowledge gained from attending continuing education courses on students' views after their education.

---

<sup>1</sup> Kirschner, P. A. (2023). *Wetenschap en ambacht: De weg naar vakbekwam leraarschap* [Science and craft: The road to skilled teaching]. *TH&MA*, 23(5), 26-30.

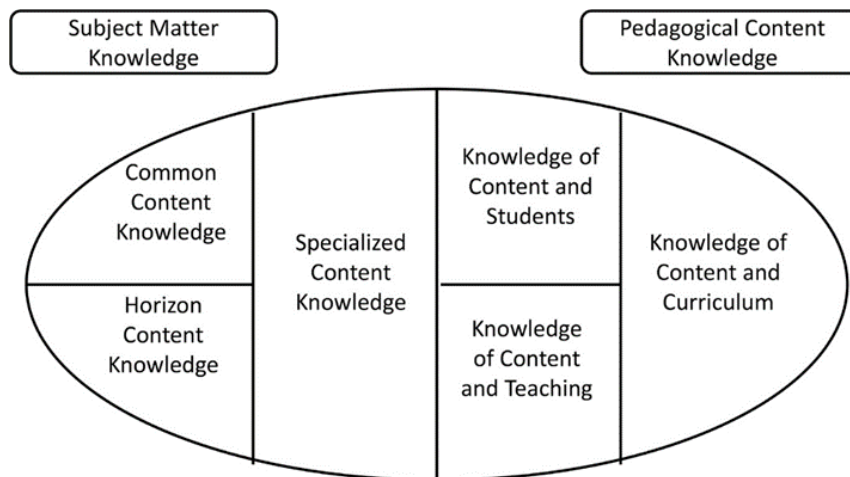


Figure 1. *Combination of Subject Matter Knowledge and Pedagogical Content Knowledge (based on Hill et al. (2008) and Ball et al. (2008))*

Actually, Van Driel and colleagues exclude *pre-service instruction* (that which you learn in training) from the acquisition of pedagogical content- and therefore craft knowledge (I'll return to this later). According to them, PCK is developed through "an integrative process rooted in classroom practice, implying that prospective or beginning teachers usually have little or no PCK at their disposal. This supports our view described above, that PCK is indeed a specific type of teachers' craft knowledge" (p. 677).

According to them, a teacher's craft knowledge is determined by their views on:

- the nature of the domain in which the teacher teaches (in their article, it is about the natural sciences, but this applies to all domains);
- teaching and learning in that domain; and
- relationships between the two.

The authors argue that in the relationships between the two, you can see a big difference between experienced and novice teachers. Experienced teachers have a conceptual framework in which their knowledge and beliefs about the subject matter, teaching and learning, and their students are coherently connected and consistent with their behaviour as teachers. Novice teachers, on the other hand, don't have such a framework; they experience conflicts between their personal beliefs about the domain, how to teach the domain, and their classroom practice.

## Five building blocks

To get this far, the question arises as to what can or should be in the training<sup>2</sup>. In my humble opinion<sup>3</sup>, a good teacher possesses in-depth conceptual knowledge and skills in five areas (or building blocks if you like), namely: subject content; cognitive and educational

<sup>2</sup> I'm not going to prescribe when in the course, with how many credits, which sources or books to include and so on. This is just about the major content areas.

<sup>3</sup> Much of what follows is based on a paper I wrote with Jaap Scheerens on what future teacher training should look like. [www.kirschnered.nl/wp-content/uploads/2022/11/Lerarenopleidingen-Nieuwe-Stijl-Final3.pdf](http://www.kirschnered.nl/wp-content/uploads/2022/11/Lerarenopleidingen-Nieuwe-Stijl-Final3.pdf)

psychology; instructional techniques; tools; and pedagogy<sup>4</sup>.

These five building blocks (Figure 2) belong in every teacher education programme.

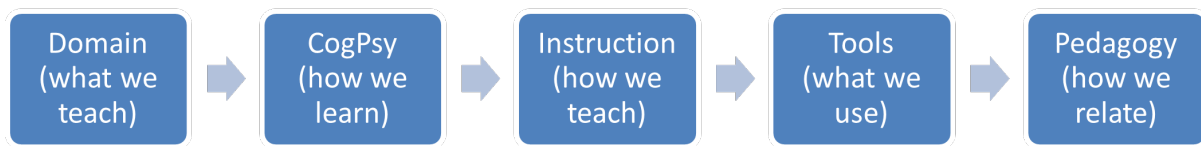


Figure 2. *The five building blocks of teacher knowledge and skills.*

### Subject matter knowledge

Subject knowledge is the knowledge of the content of the domain to be taught which teachers must master to teach at all. In chapter 16 of our book *How Teaching Happens* (2022), on Lee Shulman's 1987 article 'Knowledge and teaching: Foundations of the new reform', Carl Hendrick, Jim Heal and I summarised this as 'why you can't teach what you don't know'. Shulman described this as subject-matter knowledge which he sees as an integral part of effective teaching because it frees teachers to improvise like a jazz musician distinguishing the educator from the content specialist. In his article, he called this "the missing paradigm" in teacher education. He did so based on a comparison of certification requirements in the US state of California in 1875 and 1985.

In 1875, the requirements for teacher certification were mainly about their mastery of the domain in which they were going to teach (subject matter knowledge) plus, to a lesser extent, didactics. Teachers had to demonstrate that they had the required knowledge and skills in the subject/domain to be taught. It was assumed that if they possessed these knowledge and skills, they would also be available to impart to their pupils/students. In 1985, standards 'tilted' in the opposite direction. Content knowledge became secondary; in its place came issues such as cultural awareness, individual differences, educational policies and procedures, general pedagogy, and being able to interact with and understand pupils/students (sound familiar?).

As far as subject content is concerned, for primary school teachers, it's about knowledge and skills related to the content of the various basic subjects such as reading, writing, arithmetic, geography, social studies, general natural sciences, art and so on. For secondary school teachers, it's about the subject content of the specific subjects they teach. That subject content at all levels is in turn related to the scientific developments and standards within the domains.

### Cognitive and educational psychology

Cognitive psychology and educational psychology involve knowledge of how people take in, process and remember information, and how that affects learning. Specifically, it includes scientific insights about our cognitive architecture, such as our sensory memory (what and

---

<sup>4</sup> In Dutch and other European languages, pedagogy is the study of how one raises a child and didactics is the study of how we teach (what Anglo Saxons call pedagogy). To avoid confusion I'll often, but not always, use the word 'instructional' in English whereas I would have used the word 'didactic' in Dutch.

how we perceive; selection), our working memory (how we process information; organisation) and our long-term memory (how we remember things and make it available for further learning when needed; integration); in other words, how these information-processing processes affect what and how we learn<sup>5</sup>.

It also involves repeatedly confirmed theories of learning, such as John Sweller's *cognitive load theory*, *advance organisers* and the importance of prior knowledge by David Ausubel, *dual coding*, Charles Reigeluth's *elaboration theory*, Richard Mayer's *cognitive theory of multimedia learning* and so on. This knowledge is conditional for thoughtfully choosing the right - that is, the most effective, efficient and/or satisfactory - instruction for learning. This knowledge also prevents teachers from seeing instructional techniques and actions as merely a collection of 'tricks', or as a 'checklist' of what to do. It also ensures that a chosen form of instruction is not misapplied and ultimately prevents the 'lethal mutation' of an effective form of instruction into something that hinders or even kills learning. Finally, this knowledge makes prospective teachers into 'critical consumers' (Kirschner, Hendrick & Heal, 2022): people who can look closely at claims made by others about what is best for learning and assess whether they can positively influence learning.

In short, knowledge of educational psychology and cognitive science enables teachers to understand and evaluate possible instructional options so that they can make good choices. This can be compared to a doctor who has acquired knowledge of biology, anatomy, physiology, pathology et cetera, and can therefore choose the right intervention<sup>6</sup> to help a patient.

### Instructional techniques

Instructional techniques involve the knowledge and insights supported by empirical research and theories around effective learning and instruction (such as explicit instruction, collaborative learning, and team teaching), the choice of the desired difficulty level of the content and the step-size of the learning tasks, the different ways of testing (formative, summative, and as a learning strategy) and discussion/interaction between teacher and learner and among learners themselves. Together with the previous building block, this is about how a particular instructional technique affects or can affect the way the learner learns and then being able to choose the most effective or efficient technique to be used from it.

Despite Van Driel et al, there is a consensus that in addition to general didactics, teachers should also possess and thus be offered a certain amount of pedagogical content knowledge. As a result, well-trained teachers know how to adapt and apply general instructional techniques to their subject area to make it learnable<sup>7</sup>. Concerning PCK, this involves the most useful forms of representation of the ideas to be learned, the most powerful analogies,

---

<sup>5</sup> Learning is defined here as a stable change in our long-term memory, as opposed to achievement, which is defined as the short-term memorisation of information and how we score on a test or examination.

<sup>6</sup> A doctor has studied and therefore knows the difference between a virus and a bacterium, and how they spread and multiply so they will never, for example, prescribe an antibiotic for a viral infection.

<sup>7</sup> One possible exception is the didactics of initial learning to read and write.

illustrations, examples, explanations and demonstrations - in short, the ways of representing and formulating the subject that make it understandable to others<sup>8</sup>.

### Tools

Teachers have many tools at their disposal. Here we're talking about the whole range of tools (sometimes called media), from books, chalkboards and computer-assisted learning and/or collaboration environments to artificial intelligence and enriched (*augmented*) and virtual reality. If you, as a teacher, know the content to be taught and the way students learn and have chosen a particular instructional approach to it, you should and can make a good or appropriate choice and deploy it based on knowledge of and skills in using the various tools at your disposal.

### Pedagogy

Learning thrives in an environment where pupils have real opportunities to focus and learn. Here we're talking about pedagogy in the broad sense of parenting, raising citizens, and classroom management. How do you ensure that students have the inner peace and psychological safety to learn well? How do you ensure that you optimise or maximise the little teaching time at your disposal? How do human and world views play a role in education? What different forms of education are there?

We now know what cannot be taught in training and what must be taught in training, so we are almost there, but not quite yet.

## **Intensive induction**

If craft knowledge cannot be learnt in pre-service training, and the starting teacher is fortunate enough to get a solid knowledge and skill base in the five areas mentioned above during their training, one more thing is needed: good, intensive and well-organised supervision in the first years as a teacher. So an induction programme for beginning teachers<sup>9</sup>, a workplace-based programme that supports and helps the initial, newly qualified teacher to grow into a competent teacher.

According to Wood & Stanulis (2009), an induction programme is a formal introduction for teachers to their profession. They define such a programme as "the multi-faceted process of teacher development and novice teachers' continued learning-to-teach through an organized professional development program of educative mentor support and formative assessment" (p. 3). The programmes include reducing teaching load, extra time for planning, additional - in-service - professional development or training, timetabled teaching time to participate in these activities, opportunities to observe experienced teachers, getting non-evaluative observation and feedback from other teachers and school management, and lots of mentoring by experienced colleagues. Such extensive formal induction programmes have been shown to produce positive outcomes for beginning teachers, such as reduced attrition,

---

<sup>8</sup> When it comes to teacher education, Van Driel and colleagues' assertion that PCK as part of the teacher's craft is a complicating factor, as they argue that it cannot be taught in the pre-service training.

<sup>9</sup> I leave out post- and in-service training of graduate teachers in this article.

improved instructional quality, and higher student achievement. A solid (i.e., well-planned, formal) and for both the school and the teacher mandatory induction programme could be an important first step towards acquiring and developing teacher craft knowledge.

Is this just a dream, or are there examples of how it could or should be done? Regarding the content of teacher training courses, in England, there is an *Initial Teacher Training Core Content Framework* from the Department of Education. This framework defines the minimum rights (entitlement) of all teachers-in-training. The complexity of the process of becoming a teacher can't be overstated and it remains up to individual providers to design curricula appropriate to the subject, the stage of teacher-in-training, and the age group in which trainees (will) teach. The framework is a kind of minimum curriculum and professional standard and defines the 'baggage' that every teacher-in-training should carry as a minimum.

The English framework consists of eight standards. It would go too far to address them here, see the website for that (Department for Education, 2019b). Each standard is underpinned by research, and associated with each standard are 'learning' goals ('learning that...'), based on the best available empirical educational research, and 'doing' goals ('learning how...'), based on knowledge from research and conversations with experts, such as researchers, pedagogical centres and teachers themselves.

So much for an example of what could be done in training. But what about the craft knowledge of prospective teachers? Besides this framework, the Department for Education has also developed an *Early Career Framework* (2019a). In it, good induction is seen as a right rather than a favour or extra. The framework prescribes that every beginning teacher is entitled to two years of professional development; this is to help beginning teachers "develop their practice, knowledge and working habits". The framework provides a fully funded (£130 million a year), two-year package of structured training and support, linked to the best available evidence from research. The support includes money to roster teachers an extra 5% in the second year of work (in addition to, in England, the already existing 10% scheme in the first year), high-quality free curricula and training materials, and money to train mentors and for the guidance and support they provide.

## **Leaving as master**

Being a teacher is a combination of craftsmanship and science. You learn the latter in school and the former in the workplace. If we take the craft analogy one step further to the old guild system: there, future craftsmen entered as apprentices and left as masters. In between were several years when they learnt their trade under the guidance of master craftsmen. And so it is with teachers. In my view, thanks to a good education, they enter their chosen profession with initial competence and, thanks to a good induction programme, after several years they become competent teachers who can teach well to generations of pupils.

## **Literature**

Ball, D., Thames, M. & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389-407.

- Department for Education (2019a). *Early career framework: A framework of standards to help early career teachers succeed at the start of their careers*.  
[www.gov.uk/government/publications/early-career-framework](http://www.gov.uk/government/publications/early-career-framework)
- Department for Education (2019b). *Initial teacher training (ITT) core content framework*.  
[www.gov.uk/government/publications/initial-teacher-training-itt-core-content-framework](http://www.gov.uk/government/publications/initial-teacher-training-itt-core-content-framework)
- Driel, J.H. van, Verloop, N. & Vos, W. de (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching*, 35, 673-695.
- Hill, H.C., Ball, D.L. & Schilling, S.C.G. (2008). Unpacking pedagogical content knowledge: conceptualising and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education*, 39, 372-400.
- Kirschner, P.A., Hendrick, C. & Heal, J. (2022). *How Teaching Happens: Seminal Works in Teaching and Teacher Effectiveness and What They Mean in Practice*. Routledge.
- Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1-23.
- Wood, A.L. & Stanulis, R.N. (2009). Quality teacher induction: 'Fourth-wave' (1997-2006) induction programmes. *The New Educator*, 5, 1-23.