**Teacher education: quality not quantity for lifelong learning[[1]](#footnote-1)**

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**Introduction**

In this paper I present the idea that preservice teacher education needs to educate future teachers for a lifelong career of continual learning and also for in-the-moment action and learning during classroom life. Continual learning takes place through reflective practice with colleagues, as well as with outside input, and in-the-moment learning requires a state of professional readiness to learn. In common with other professions that involve purposeful interactions with other people it is not realistic to think of teaching merely as the application of previously learnt knowledge and behaviour. Instead the act of teaching integrates many human qualities, including professional, pedagogic and subject knowledge, but also a holistic state of being in which relationships, interactions, creativity when immersed in tensions, and the maintenance of purposeful environments imbue workplace actions and decisions. I shall examine the implications of this view of teaching for the provision of preservice training.

**Models of teacher learning**

Dominant models of learning to teach used to assume that preservice teachers (PSTs) were first concerned with acquisition of knowledge and then, when they started teaching, their own behaviour in putting this knowledge into practice. This focus on self was then seen to progress towards a focus on children's behaviour, and finally PSTs would begin to think about whether children were learning when they realised that a key component of classroom management was to design lessons that were appropriate for learners, and pedagogy that promoted and valued learning. In other words, thinking about children as learners has been assumed to happen *after* teachers have developed day-to-day functioning (Furlong and Maynard 1995; Kagan 1992). If the key to teaching well is suitable lessons that promote learning, then subject knowledge must also be a component of learning to teach, so a more developed model might be that PSTs first learn relevant subject knowledge, then learn how to control a classroom (Tamir 1988).

This model is currently observed in some UK routes into teaching in which high achieving graduates are given a compressed course about classroom management and then enter the profession (Get Into Teaching 2015). What is missing from this model is any off-the-job in the process of transforming knowledge into explanations, and it is not unusual to find entrants to the profession claiming that the key to effective teaching is 'clear explanation' and then children will learn (Hillier 2013). While this may be an articulation of how they think they learnt, and indeed there are learners and types of knowledge for which clear explanation is adequate (Cruikshank and Metcalf 1994), it is very easy to contradict this model by suggesting that if teaching is only about 'clear explanation' then all one needs to become a teacher is a resource giving all the necessary 'clear explanations'. Such resources might exist, but would be unusable because of the amount of detail and alternatives that need to be included to learn to teach a significant swathe of a whole curriculum.

Several aspects of teaching are missing from both these models, most obviously any early consideration about how children learn in classrooms. We have many descriptions of how children learn in laboratory and clinical conditions (e.g. Piaget 1959), and how learning takes place in situations where there is a shared goal or task (e.g. Bruner 1985; Lave and Wenger 1991), and how learning takes place in relation to digital tool use (e.g. Säljö 2010). We also have some descriptions of how children might learn in certain kinds of classroom modes: direct instruction, groupwork, discussion, using multiple representations, using dynamic software and so on (see for example Fuller and Clarke 1994). We have descriptions of how different types of classroom task promote learning (e.g. Foster and Skehan 1996; Pfister and Oehl 2009) and from these can deduce that some teaching strategies that might be more effective than others when cultural considerations are taken into account (e.g. Brousseau 1997; Sato 2003). Some of these also take the nature of knowledge into account, and some do not (Watson 2004). Another aspect that is missing is how, apart from 'clear explanation', personal subject knowledge can be transformed into knowledge-generating experiences for children through observations, tasks, dialogue and other experiences. The question for teacher educators is how to incorporate these aspects into teaching training, because clearly there is not time for a transmission model of teaching and learning to be enacted, nor is there evidence that being told how and what to teach is successful.

**Pedagogical subject knowledge**

In an effort to learn more about how knowledge is transformed into lessons by expert teachers, many researchers have observed teachers and analysed the kinds of knowledge they draw on when in the flow of lessons and school life, and these have been categorised to show how complex teaching is. This trend is generally said to start with Shulman (1987), although Plato also indicated something of this rather earlier in his dialogue with Meno.

Shulman's categorisation can be summarised as:

* General pedagogical knowledge
* Knowledge of learners
* Knowledge of educational contexts
* Knowledge of educational purposes, values, etc.
* Content knowledge
* Curriculum knowledge
* Pedagogical content knowledge (p.8)

The notion of pedagogical content knowledge has been further developed in mathematics by Ball and her colleagues (Ball, Thames and Phelps 2008)(Figure 1)and in science by Lee and Luft (2008) (Figure 2).



Figure 1. Domains of mathematical knowledge for teaching (Ball, Thames and Phelps, 2008 p.403)



Figure 2. Seven components of PCK and specific elements within each component, from Lee and Luft (p.1352)

Such models have been challenged as being over-simplistic (e.g. Petrou and Goulding 2011). In mathematics Helen Chick and her colleagues produced a framework (Figure 3) that seems to take the nature of mathematics pedagogy into account in a more nuanced manner. The result is a complex model that describes the integrated nature of teacher behaviour, and its components cannot possibly be taught separately for all mathematical topics. Chick et al's framework is intelligent as a description, but useless if used as a formula for teacher education. Instead it raises a more important question: what kinds of preservice experience do teachers need to have in order to be able to act fluently combining these different facets of teacher knowledge?

**How teachers learn**

First, we have to understand more about how teachers become expert at this fluency, because it is obvious that they did not become so by being taught all the necessary knowledge in pre-service training. Researchers in Oxford undertook a longitudinal study of the developing expertise of beginning teachers (Burn, Hagger, Mutton, and Everton 2000; Burn, Mutton, and Hagger 2010) and found that many PSTs were capable of focusing on student learning from the very early days of their courses, and also that a coherent way of distinguishing between different PSTs on the pre-service course, and differences in their development during their first few years of teaching, was to place their orientations, as analysed by the researchers, on five spectra of professional practice indicated by the arrows in Figure 4.



Figure 3. Framework for analysing Pedagogic Content Knowledge (from Chick, Baker, Pham and Cheng (2006) p. 2-299

Figure 4: Orientations to learning among new teachers (adapted from Burn, Mutton and Hagger 2010)

Eventually, during their first employment as teachers, these differences all seemed related to how the new teachers responded to their working context, so that those who capitalised on context seemed to be flourishing rather more than those who felt constrained. How they combined knowledge in those contexts was described by one PST as:

*You’ve got the school influence here and then you’ve got the college influence here and the theoretical bit and the core studies and the subject studies bits all mixed in with that, and then you have got your own experience of teaching and your own personal experiences. So you are constantly kind of drawing on all these bubbles, drawing them down, drawing on different elements.*( Hagger, Burn, Mutton, and Brindley 2008 p.169)

Ball's and Lee and Luft's models both give explicit places to PSTs' own mathematical subject knowledge, Ball at al. calling this 'common knowledge', i.e. that which an ordinary educated person might be assumed to have, and 'specialized SK', i.e. that which someone who has specialized in the subject can be assumed to have. Lee and Luft leave this aspect united as 'subject matter' in science. Since many science teachers have knowledge of one branch of science, but may be expected to teach another (e.g. a biologist teaching chemistry; a physicist teaching environmental sustainability), Oxford researchers asked whether and how such specialist knowledge can be learnt in school by PSTs in their practicum, or when fully employed as teachers (Burn, Childs, and McNicholl 2007). Their work extended beyond science as a subject. They identified ways in which this subject learning could happen and offer examples of feasability. The critical features of workplaces in subject learning took place included: a professional work environment conducive to informal talk during the working day; knowledgeable colleagues, schemes of work and textbooks; a collaborative culture of exchange and openness that is non-judgmental; reciprocity in the day-to-day atmosphere; co-planning and co-teaching.

The kinds of knowledge that could be 'learnt' in these conditions included knowledge of representations and strategies and practical considerations of teaching, as well as knowledge of underlying principles. However, it could be said that the subjects they researched have commonly understood methods of enquiry: scientific and historical methods that can be applied across topics. For some other subjects, e.g. mathematics, there is something missing from this school-based learning model, which is the teacher's personal experience of subject-specific methods of enquiry, such as investigating, proving or problem-solving, and this could also be said to be missing for someone who is teaching science but has no experience of 'doing' science.

**Personal and pedagogical subject knowledge in professional learning**

How, then, can deficits of personal subject knowledge be addressed with PSTs? Chick's and Ball's models both demonstrate subject specific facets of knowledge that are necessary for teaching, but it cannot be guaranteed that disciplinary qualifications in the subject will give appropriate experiences. It is possible to design subject-specific courses in subject knowledge that give PSTs the insights necessary for transforming SK into good subject teaching, while understanding and respecting the PST as a future professional and hence offering ways of learning that are appropriate. Examples of this approach to subject knowledge can be found in inservice provision, but are equally suitable for perservice provision.



Figure 5: Online task matching bottle shapes to volume graphs: from http://www.canterbury.ac.uk/study-here/courses/postgraduate/maths-ske.aspx

For example, in a unit introducing fundamental concepts in calculus designed as an inservice or preservice knowledge upgrade for non-maths graduates, we find a fairly well-known classroom task presented for teachers (Canterbury Christchurch University 2015). The initial task is to match graphs of height of the waterline against volume of water that can be contained in various bottles (Figure 5). There is a sequence of tasks that teachers are supposed to undertake and I have constructed a table (Table 1) to show how subject pedagogical insights are merged with mathematical insights during those tasks.

It is sometimes assumed that teacher education needs to attend to all the different kinds of pedagogical knowledge identified by various researchers. However, this assumption is a category error. The professionals whose work has been analysed to produce these categories did not become expert by learning all these types of knowledge separately, but by learning to act fluently in a complex world.

I offer this analogy. To make a cake one needs a range of knowledge: how to weigh; some everyday psychology of food; some knowledge of taste; how to beat air into an egg; how to follow instructions; how the oven works; where the equipment is; and so on. If someone has been taught all these separately and is then asked to make a cake in an unfamiliar kitchen, with a new recipe, possibly not written in their first language, and maybe from some authoritarian source, they are unlikely to make a very good cake without significant support and may be drawing on knowledge and experience that they have not been recently taught (such as 'hot things hurt' or 'lemon juice curdles milk'). So it is with teaching: prior knowledge of separate components of teaching is hard to put into practice. Even personal subject knowledge is not always helpful when listening to a child's attempts to reason - as many high-achieving graduates find out when they first start teaching children who are less responsive than they imagine themselves to have been.

The task sequence described in Table 1 gives an example of complex experience that can be discussed from mathematical and/or pedagogical standpoints, the pedagogical standpoint giving access to several strategies which may or may not be topic specific and the mathematical standpoint giving a connection between the forthcoming algebraic treatment of rate of change (early calculus) and modelling realistic data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Task** | **Mathematical knowledge** | **Implicit/ Explicit** | **Pedagogical knowledge** | **Implicit/****Explicit** |
| Print and cut out the 15 cards |  |  | Production and use of materials, possibly encouraging group work | I |
| Match six of the graphs with the respective six containers | Connecting shape of bottle with graph involves anticipating how gradient changes with the slope of bottle sides | E | Matching different representations encourages deep engagement with concepts | I |
| Analyse the three remaining graphs and try to determine the shape of a bottle for each one | Convert graph gradient to slope of bottle; think about meaning of rate of change | E & I | The matching is not one to one so has to be done conceptually; cannot be guessed | I |
| Draw two new containers and produce appropriate graphs | A third way to consider how rate of change; physical phenomenon can be depicted on a graph | E | Design a matching task; think about what features can be matched and are not in the six given cases | I |
| What the curves of the graphs tell you | How curves depict covariation of two variables | E | Value and challenge of expressing meaning | I |
| Why some curves are steeper than others | Values of first derivative (gradient) | E | Using comparison to deepen explanation; comparison brings awareness of important differences | I |
| How to explain to someone who does not understand, why several graphs are curves and not straight lines | Difference between constant and variable rates of change | I | Construction of explanation of variable rates of change, given two representations: topic specific | E |
| What language would be used to explain the differences? | Introduction of precise language, technical terms and definitions | I | Value of experience for learners that they can describe and compare in several different ways before a formal idea is named and made precise. | E |

Table 1 Subject and pedagogic learning made possible in the bottles task

The task sequence comes from an online resource to enhance teachers' subject knowledge so the opportunity to discuss the different matters that arise, especially the implicit features, has to be organised separately, locally where the teacher is. Notice, however, that the final tasks make explicit what was implicit earlier. Furthermore, the whole task design structure models a way of thinking about developing personal and pedagogical knowledge together, thus laying foundations for lifelong learning. The task sequence is from a large collection of similarly constructed sequences for other mathematical topics, so a PST working through them will develop an expectation and habit of working on subject knowledge in complex ways. This kind of integration is typical of many face-to-face teacher education approaches (see examples in Hillier 2013; Watson and Bills 2010; Watson and Mason 2007) but not all online resources achieve this integration.

**Learning for in-the-moment decisions**

Having talked about how lifelong learning can become a habit of subject knowledge development, I now turn to the very short term learning opportunities that arise in moments during teaching. Such moments arise when what happens in lessons is not what was anticipated in planning. These usually arise from the inevitable systematic tensions I have depicted in Figure 6. In this figure I have used arrows to show where differences arise that can create confusion, puzzlement or panic in new teachers. Although these are difficult tensions to overcome, new teachers do need to be aware of them and recognise them as needs for pedagogic problem-solving.

Figure 6: Possible tensions arising for the teacher in the classroom that generate in-the-moment problems

Even if a new teacher is well-qualified in a subject, and has planned thoroughly, there are plenty of opportunities for surprising and unexpected events and responses to tasks. Any PST course needs to prepare teachers for these in some way. Rowland and his colleagues call these 'contingencies' (e.g. Rowland, Huckstep, and Thwaites 2003) and there are different cultural practices between teacher educators and teachers for working with these. For example, some educators will give PSTs post lesson advice on strategies they could have used in situations that arose in an observed lesson; others will anticipate before the lesson, based on their own experience, and ask for more planning to take account of further eventualities. Others will ask the PST to reflect on events *post facto* and make conjectures about what could have been usefully done, thus indicating the value of reflection. Others will suggest readings that might inform similar situations in future. These advisory and educative approaches are rather different in preparing teachers for future learning; the first depends on someone else's expert knowledge, the second on a problem-solving approach to becoming a teacher (see Feimam-Nemser 2001). Both depend on the belief that a teacher builds a repertoire of strategies over time and this is an aspect of professional learning. Another approach is collective, in which a group of teachers might co-plan a lesson and between them anticipate more possibilities than a new teacher can do on her or his own, this collective knowledge is then seen as common professional property (e.g. Doig and Groves 2011), Teacher educators who only judge shortcomings are not contributing either to lifelong learning or to in-the-moment learning.

**Where can learning take place?**

Having discussed the nature of knowledge for teaching, and how learning might be developed as a professional habit, the question of location of learning arises. In the approaches to in-the-moment learning I have just described it is assumed that learning takes place before, during and after taught lessons in school, but there are ways of bringing such experience into group sessions in institutions using video (e.g. Santagata, Zannoni, and Stigler 2007) or even cartoonisation (e.g. Herbst, Chazan, Chen, Chieu and Weiss, M. 2011). Carefully designed task sequences, like the filling bottles task, can be undertaken either at an institution with others or in individual online study but organised discussion and reflection in an institutional context helps the teacher feel like a member of a professional learning community.

Since ultimately all knowledge for teaching is acted out in classrooms, and it seems important that new teachers need support to capitalise on their context rather than be constrained or overwhelmed by it, some PST experiences need to take place in schools with a mentor who understands the need to develop lifelong learning and also to reflect on in-the-moment experiences. However, learning *in* school cannot be enough, because in the busy life of schools there is no time to engage with, at the very least, the methods of enquiry in a subject, and also to develop pedagogical and subject insights from extended activities that have been specially designed for learning, such as the bottle filling sequence. There is seldom time to think about alternative and unfamiliar teaching methods and innovative practices in most working conditions.

Schools can provide the site for action, for experiencing in-the-moment decision-making, for testing ideas, for using subject knowledge from a specific pedagogic standpoint normal to that school, for finding resources, for receiving educative feedback, and for seeing models of practice and professional learning. They cannot in general provide opportunities for deeper reflection and learning without some embedded regular professional development practices, and even where schools do provide these the input from educators who have wider experience of several schools, and maybe research literature, is limited.

Universities and other institutions can provide: subject knowledge from a general pedagogic standpoint, often informed by research; knowledge about materials, language, possible conceptualisations, contexts for learning and contexts for application; direct experience with the methods of enquiry of a subject; knowledge of what there is to learn, and how learning can happen in practice; a background of sufficient psychological and sociological understanding necessary to make teaching and learning possible and effective; attunement to the need for awareness in teaching, such as through lesson videos.

**Conclusion: partnership and conditions for effective learning**

The notion of partnership, so prevalent now in PNG society and economics, makes good sense here but new teachers should not feel that they are pulled in contradictory directions. The business of schools is primarily to teach their children and raise their results (and hence life expectations) within the norms of their practice; the business of universities is to prepare PSTs by giving them access to knowledge and ways of learning. Thus for a school/university/PST partnership to work, all participants in it have to have a shared view about the preservice experiences that are conducive to effective initial learning, the competence to make in-the-moment decisions, and the development of lifelong professional learning. In addition they have to have agreement about how these views will be enacted using the different learning environments and their potentialities.

This view of teacher learning, focusing on both the brief moments of classroom life and the long term development of the teacher, will contribute more to the development of a professional body of teachers than a linear view of learning as putting previously acquired knowledge into practice.

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1. Presentation at National Education Conference 2015, University of Goroka, Papua New Guinea [↑](#footnote-ref-1)