Chapter 7: Technology to provide educational practitioners with the expertise they need

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Introduction

In this chapter, Kaśka Porayska-Pomsta, Christina Preston, Charlotte Laerke Weitze and Sarah Younie explore how technology can help teachers gain the skills and expertise they need to be effective.

It is often assumed that the primary role of an educational practitioner is to create effective and motivating learning opportunities for learners. Following some initial training, educational practitioners are expected to be ready to take on the challenge of supporting learning in diverse contexts and specific subjects of their specialisations. As such they are expected to be experts in their trade, to know how to design for learning and how to create motivating environments that will bring optimal outcomes for learners (e.g. Duffy, 2005; Lin et al., 2005; Porayska-Pomsta, 2016). However, research related to educational practice and to the nature of teaching expertise suggests that such assumptions and the aspirational rhetoric that accompanies them stand in stark contrast with the reality of many educators' ability and readiness to consistently provide such stimulating environments. Pre-service teacher training alone seldom develops educational practitioners into adaptive decision-makers who are able to cope with the dynamic and only partly predictable learning contexts (Duffy, 2005; Buchmann, 1990; Windishith, 2002, Lin et al., 2005).

Research concerned with defining teaching expertise reveals that it is a complex construct, which is shaped by the multifarious, transactional and context-dependent nature of learning and teaching and that it operates at multiple levels of knowledge and skills. For example, Shulman (1990) defines teaching expertise in terms of four broad types of knowledge: (i) repertoire of content knowledge; (ii) pedagogical content knowledge; (iii) curricular knowledge, including a good grounding in the philosophy of the subject; and (iv) knowledge of how to negotiate between those aspects of the learning situations that are related to the learner and those that are related to the content taught. Narciss (2004) refers to such expertise as educational practitioners' ability to recognise and match their feedback to the specific cognitive mindsets experienced by learners moment-by-moment and to their ability to adapt their support routines to the specific content being taught, and to the individual knowledge and motivations of the learners.

Verschaffel et al. (2009) and Godau et al. (2014) distinguish between routine expertise and *adaptive expertise*, drawing on Hatano and Inagaki's (1984) description of adaptive expertise in terms of a teacher's flexibility to use multiple strategies and their ability to choose between such strategies adaptively. Both *flexibility* and *adaptivity* are considered essential to teachers ability to support learners' individualised learning processes and to their ability to cope with "the cyclical and recursive dynamic of [such processes, along with] the implications of this dynamic on motivational, cognitive and emotional [states of learners]" (Christophel et al., 2014, p. 2). Dale (1998) suggests that to become a professional teacher, the educator must be able to reflect on and to develop their practice systematically in collaboration with colleagues and with reference to professional theory. Dale calls this collaborative development a teacher's *third competence level* (Comp3), with the first competence

level being the execution of teaching (Comp1), and the second level – the planning and discussions with peers about every day challenges (Comp2). The third (Comp 3) level represents a space for teachers' to interrogate their learning designs and for critical reflection thereupon, as well as for the professional development and research. Although the process of engaging in such critical reflections typically extends beyond teachers' daily obligations, it is of fundamental importance to the development of best teaching practices.

The predominant picture that emerges from the various accounts of what constitutes teaching expertise is that teaching is a "dilemma ridden endeavour" (Duffy, 2005; Buchmann, 1990; Windshith, 2002), whereby teachers have to make decisions about how to handle several and frequently competing aspects of learning situations, and where they must adapt to such situations *on-the-fly*. Christophel et al. (2014) use the term *adaptive expertise* to refer to the combination of those two competencies, whereas Duffy (2005) refers to *adaptive decision making* and he, like several other researchers, links the development of such competencies to the need for an investment in supporting teachers' in learning how to engage in a continuous and targeted introspection, reflection *in* and *on* action (Schön, 1987), and adaptive metacognition (Lin et al., 2005).

Research evidence suggests that adaptive metacognition is key to supporting both the understanding and the establishment of best and innovative teaching practices and to offering an effective basis for educators' life-long professional development (Lin and Schwartz, 2005; Hewitt et al., 2003; Lin et al., 2005; Laurillard, 2012; Cohen and Manion, 1980; Conlon and Pain, 1996). However, one of the primary challenges in supporting teachers' metacognitive development relates to helping them recognise that apparently routine situations often have a number of

hidden features. Frequently, teachers' practices are entrenched in their perceptual abilities and habits through which they make sense of complex teaching situations and which rarely if at all involve conscious reflection or judicious application of principles of good practice (see also Hewitt et al., 2003 for a discussion of 'gestalt'). Nevertheless, Korthagen and Kessels (1999) suggest and Hewitt et al. (2003) and Lin et al. (2005) show that teachers' habitual practices and interpretations of teaching situations may be changed when externalised in the form of conscious mental representations and when critically reflected upon. Lin et al., (2005) and Hewitt et al. (2003) provide some compelling evidence of the relationship between teachers' purposeful rooting for and observing the hidden features in the teaching situations they encounter and their adaptive metacognition (see also Lin and Schwartz, 2003; Dweck, 1999). Lin et al. (2005) provide evidence that teachers' searching for detailed information in the situations studied increases the specificity of their analysis of those situations, as well as it reveals hidden aspects of those situations. Hewitt et al. (2003) highlight that the timing of the reflections is of crucial importance, with reflections immediately following the events of interest facilitating greater, more situated and precise recall. Finally, Lin et al. also emphasise the key role of digital technology in capturing and accessing both the critical episodes and in scaffolding teachers' perceptions thereof in learning situations, especially in helping them to home in on the absence of important information.

This chapter presents three examples of how educational practitioners' continuous development of metacognitive skills may be supported through design and application of different forms of technologies in a variety of educational contexts. The first example describes a small-scale design-based research process of engaging professional teachers in Denmark in a scaffolded reflection on and design of best

pedagogical support practices in the context of a technology-enhanced learning environment called Global Classroom. The example also discusses the need for the development of sustainable means for interrogating pedagogical support practices by investigating how the establishment of a community of practice in the specific institution might allow teachers to engage in a continuous and on-demand access to collaborative critical reflection, which is of crucial importance to enabling pedagogical innovation. The second example illustrates the use of in-class video technology in combination with real-time coaching feedback delivered through an in-ear device to front-line teachers. Combining such technologies with human coaching in real time teaching situations aims to improve teachers' self-awareness while delivering learning support, and to allow them to interrogate and improve their practices. The third example demonstrates how engaging university tutors in the process of designing an intelligent tutoring system through knowledge elicitation may serve to enhance their awareness of students' specific behaviours at a fine-grained level of detail and their understanding of the relationship between such awareness and tutors' feedback choices during learning interactions. Although very different in terms of the technologies described and their epistemological origins, all three examples are concerned with enhancing educational practitioners' critical reflection skills as a way of enabling them to become adaptive decision makers and pedagogical innovators. The questions of shareability of the practices related to teachers' metacognitive competencies and pedagogical innovations, as well as the question of how and when best to facilitate educational practitioners' reflective processes are of central concern in all three examples.

Example 1: Developing innovative Pedagogical Space and Practice

Global Classroom (GC) is a learning environment implemented in a two-year full-time upper secondary general education programme for adult students, where students can choose between in-class participation or learning through video conferencing (Fig. 7.1). GC has been introduced in the adult education centre (VUC) in Storstrøm, Denmark to deliver learning support in a variety of different subjects. However, to date, there have been no guidelines available for employing best practice for supporting learning in this new context. Initially, when faced with this new learning environment, teachers reported that they: (i) lacked the competence to teach within it and that their previous learning designs could not be used; (ii) lacked the time to develop learning designs that would suit the new technological learning environment; and, (iii) had a need for extended support in pedagogical innovation from the educational organisation.

Figure 7.1: The Global Classroom - A hybrid synchronous video-mediated learning environment.

In response to the teachers' reports, six workshops were organised with the purpose of exploring and establishing new practices of relevance to the VUC's GC and to allow teachers to engage in co-design of new practices of relevance to this new environment (Fig. 7.2). Three different teacher teams participated in the workshops over the six meetings. The overarching aims of the six workshops were to: (1) develop approaches which were both grounded in theory and that were feasible and effective at a practical level; (2) construct an agile working practice that enabled the teachers to change teaching strategies in relation to the dynamically emerging demands in specific learning situations and to any strategic changes of the organisation; (3) provide a

structured, reflective means for teachers to experiment with different designs and to enable rapid adoption by VUC as an institution of the solutions proposed. Learning goals[1] were established to provide the basis for the professional development and for the creation of learning designs during the workshops. The workshops were intended to allow the participating teachers to:

(1) Carry out appropriate planning, execution and theorising with respect to their own teaching in IT-based and video-mediated teaching programs.

(2) Make informed and relevant choices in the use of educational technology for their learning designs in a professional academic context.

(3) To investigate the means for knowledge sharing, communication and decision flow between the administration and the teachers.

Figure 7.2: A teacher team working together partly on-line during workshops made it easier to meet.

An IT-Pedagogical Think Tank for Teacher Teams (henceforth referred to as *ITP4T*) was developed as a consequence of the workshops. The ITP4T was a framework for facilitating reflection and learning design creation by teams of teachers at VUC. Teachers met every week for two-hours over a six week period to address specific pedagogical challenges of their own choosing. During this process they followed a specific procedure (described in detail later), requiring them to set the

[1] **Learning Goals for the Six Workshops:** After the course, the team members will be able to do the following:

1. Describe own learning design and identify and formulate possible problem areas in the current educational context.
2. Select and plan the use of and create a process of collective reflection about relevant literature in relation to the team's experience of current issues.
3. Develop and carry out a process leading to individual goals for innovation, both in the short and long term.
4. Master innovative tools that can be used in the innovation process in a pedagogical team.
5. Be innovative concerning their own teaching, involving technology as well as new/innovative learning designs.
6. Organise and lead an innovative team process.
7. Choose a strategy and method for knowledge development, knowledge sharing and anchoring in the team.

goals and milestones for their own continuous competence development and to collaborate with one another with respect to those goals.

To identify the goals and milestones, during the initial two meetings, teachers clarified the problem areas through discussion and brainstorming. They recorded their problem areas both individually and as teams in a written form. They created a "problem-bank" of all the challenges that they wanted to address and ultimately solve as well as a "wish-list" of the specific competences they wanted to develop. They wrote this up in an online interactive project development tool called Trello[2]. This made it accessible for all team members and made it possible for teachers to jointly set priorities, to return and to alter them if needed. In this way, the specific problem and competence development areas were turned into short and long term goals. This is illustrated as the black goal-dots on the coloured lines in Fig. 7.3. As time passed, new goals were set and the teacher's level of competence increased. For example, teachers' areas of interest included: (i) problematic themes from the technology enhanced learning environment (TELE); (ii) ways in which to create innovative learning designs for the learning environment; (iii) questions around innovative use of educational technology and (iv) issues and questions related to teachers having to study professional theoretical literature, new research, Edu-blogs, videos etc. Teachers discussed how to evaluate whether the issues and challenges identified were solved or the goals reached. By being very clear on their goals for competence development, learning and innovation, they became very aware of how and when they gained new competences. Furthermore, they reported that the competences gained were relevant and inspiring for their daily teaching practices.

[2] www.trello.com

Figure 7.3: Goals, milestones and competence levels in four types of processes in professional development and innovation for teacher teams.

The ITP4T think-tank process for reaching the goals was structured around a cycle involving five stages of design and reflection, including: (i) input/ presentation; (ii) reflection/ innovation/ discussion; (iii) evaluation; (iv) anchoring/ documentation/ dissemination; and (v) 'I dare you'. Teachers worked in teams through this process during weekly two-hour meetings, at each meeting covering all five stages. Teachers reported that working within this structure provided the support they needed to achieve pedagogically innovative results. We now explain each of the stages in turn.

Figure 7.4: Weekly points consulted when working in the IT-Pedagogical Think Tank for Teacher Teams (ITP4T).

Input/Presentation (this is indicated in Fig. 4 by the node A) of the chosen problem area/theme was conducted by the team leader of the day. The team members took turns at being team leaders. The problem area/theme chosen was always one that related to a real *burning problem* or to an idea for a solution to a burning problem, and it was inspired by the teachers' competence development goals (Fig. 3). Every week all team members prepared for an hour for the theme of the week, which was laid out by the team leader. By preparing and investigating the subject in advance, the team leader would become the expert in relation to the specific problem and the possible solution to it.

Reflection/Innovation/Discussion (node B) relates to the ideation and development part of the think-tank. Grounded in theory and inspired by the team leaders' presentations, the teachers engaged in brainstorming and informed discussions about the theme chosen for the week. The team leader of the day had planned activities for how the team could work and discuss a given theme. For example, this could take the form of discussions about the burning problem, drawings of new learning design concepts, or experimentation with technological devices. During the sessions, teachers came up with suggestions for new learning designs and were able to explore the pedagogical challenges that were familiar to them, and to invent new ways of addressing those challenges. They engaged in reflective and innovative work (Dale, 1998; Darsø, 2011) in a way that corresponds directly to Dales' (*ibid*) third level of teacher competence (Comp3). This level involves teachers abandoning their daily practical routines and instead creating a professional space for pedagogical reflection. This space is a place for dialogues, indepth critical reflections, development and research. The participating teachers also kept track of *what they knew* and *what they did not yet know*, and they used structured methods to conceptualise and discuss the problem areas. They also aimed to create a friendly and open space for this conceptualisation, reflection and innovation to take place. Teachers emphasised the importance of one person taking responsibility for keeping discussions at the Comp3 level of Dales' competence description in order to enable collaborative reflection; in this way, they avoided a pitfall common to group work of focusing on high-level discussions about common projects or venting frustrations rather than creating new solutions and solving their own complex and burning problems (Tingleff, 2012). Teachers emphasised the advantages of consciously developing positive team relationships within which asking provocative questions that

went beyond the team members' established experiences and teaching norms was acceptable. For example, some team members believed that they had tried everything in the approach to solve a problem, but still failed to reach satisfactory results. By allowing themselves to ask challenging questions, the teacher teams were able to move beyond the frustrating experiences to finding and rehearsing new solutions to their burning pedagogical problems.

Evaluation (node C)**.** Following the development part of the workshop, teachers discussed new learning designs or new concepts identified in relation to the challenges explored by them within the context of the GC learning environment. They both evaluated the various competence goals they had set themselves for the current day or the long term, and they discussed additional future aims and goals for competence development. These new goals were then added to the list of goals defined previously. The teachers found this evaluation process important and helpful because it forced them to formulate their new concepts in a language common to all participants. This in turn allowed them to critique and to receive the critique from other team members. The evaluation process also supported the team in prioritising and formulating their future goals for competence development.

Anchoring/Documentation/Dissemination (node D)**.** For the benefit of memorisation and common explicit conceptualisation of the innovations and solutions, knowledge sharing took place in a structured way within an online platform that was available to all teachers and to the organisation. When the teachers collaborated in the ITP4T to create new learning designs, one of the digital tools they experimented with was *Learning Designer* (Laurillard, 2012). The teachers often used this tool in the documentation phase in the ITP4T. The tool makes it possible to create "pedagogical patterns" for learning designs that later can be shared and discussed

with other teachers. Teachers could choose between a range of features, for example, various pedagogical approaches or activity types: (read–watch–listen, collaborate, discuss, investigate, practice and produce). This gave everyone an opportunity to participate in the creation and use of the new knowledge. This tool enabled collaboration during the creation of new learning designs, because teachers could easily compare and discuss approaches to good learning designs even though they taught different subjects.

Several of the teachers identified a need for *anchoring and dissemination* of the new knowledge at the school. They proposed to establish regular open workshops, during which all teachers would have the opportunity to meet and learn from each other. A continuous practice like this, with various participating teacher teams, could establish common ground and create a foundation for a community of practice in this area. Since well-designed communities of practice are forums that support the "living nature of knowledge", the types of new practices explored within the ITP4T could serve to support sharing of new knowledge (Wenger, 1998). One suggestion about how to disseminate the new knowledge was that since each team leader had researched specific problems and solutions when working in the ITP4T they hereby had become experts in the subjects for which they had been "primary investigators". Therefore, they could take a new role as disseminating experts within their specific area of interest in the educational organisation. Another example of dissemination, suggested by one member of the ITP4T was: "[…] making small videos with each individual teacher's new innovations and ideas. Then it would also be available for everyone to be inspired by, independently of time and place". These are only two of several suggestions made by teachers about the possible ways in which to anchor,

document, disseminate and share the new knowledge created by the teachers in the organisation beyond the ITP4T.

'I dare you' (node E) consisted of teachers having to create a *product* and to *reify* their thinking for the next team meeting to enable them to engage in a grounded and concrete discussion. This activity was initiated by the team leader of the following week. It was important that some of the tasks consisted of conducting experiments in the class since the main aim for this think tank was to create motivating learning designs for the students. The tasks also consisted of finding and reading new materials related to a specific problem area, or finding and experimenting with new educational technology. Teachers noted that this product creation or reification was crucial to their being able to move forward in their competence development (Wenger, 1998). They also emphasised that "I dare you" made a big difference to them. As one teacher stated:" this is a big difference from traditional team meetings - in ***I dare you*** we change roles becoming students and innovators, and by studying or experimenting between the team meetings, we meet each other on informed ground at next meeting, and this gives us an opportunity to move beyond the experiences we have from our daily working life – this really provides tools to move in new directions." Having experienced the value of such in-between meetings activities to their creative competence development, teachers made a commitment to each other to dedicate as much time to such activities as possible. Following the completion of "I dare you stage", the ITP4T cycle involving the five stages of design and reflection would start all over again the following week using a different challenge, thus enabling continuous competence development for and by the teachers (Fig. 7.4).

While the ITP4T proved a good frame within which to enable teachers to engage in developing and evaluating new learning designs and in trialling the possible ways in which knowledge sharing and co-creation could be facilitated at the VUC, these innovations would not have gained much traction within their real practices without buy-in from someone with executive powers within the organisation. This is why the workshops also involved the manager (the head of the department) who participated for 10 minutes in every workshop. He reported that it was valuable for him to get insight into how and what the teachers discussed and innovated on. By participating in ITP4T sessions, the manager was inspired to find new ways to share knowledge in the organisation, and also learned about the teachers' new skills. The teachers reported that the manager's participation made them feel that he was interested in their new designs and that this was motivating for them.

To conclude this example, the teachers participating in the ITP4T found that the relatively tight structure of the five-stages worked well insofar as it enabled them to develop many new ideas. They all used their new learning designs with the students, and some of the designs were used by several of the teachers. One teacher working in ITP4T said that: "Pedagogically, it's very much about how to think new thoughts and how to think outside the box, and this is perhaps what we have come a long way doing. This also means that in the future we will be able to explore different places than we normally would".

The teachers agreed that it would be valuable to go through four or five ITP4T workshops twice a year, depending on the number of team members. This would make the foundation for continuous competence development and would meet the teachers' continuous need for pedagogical innovation. As a consequence of this, the

organisation has decided to educate a member of the pedagogical IT staff to coordinate the initial phases for new ITP4T teams as they learn to work in the model.

This example illustrates how innovation, knowledge-development and knowledge-sharing processes may be supported when teachers create learning designs in a concrete model such as ITP4T and how this process might contribute to the organisational learning process. When using this framework, the teachers became innovative learning designers developing new knowledge about learning designs, new use of technology and new ways of sharing knowledge in their educational institution. All teachers engaged in developing new pedagogical strategies, exploring and applying new technology and new learning designs in their existing practices. All teachers contributed to reflections on how to design a strategy and method for knowledge development, knowledge sharing and anchoring at the organisation. They co-designed and tested the development of a practice for a new organisational learning design. Using this new practice enabled the teachers to transform non-knowledge or problems into ideas and pedagogical innovation and then back into new anchored knowledge. They acted as team managers for each other and were able to design and create pedagogical processes with collective reflection using relevant tools and methods to facilitate the common ideation phases for the team, leading to individual as well as team-based goals for innovation (Brown, 2009; Dale, 1998; Darsø, 2011). Their technological literacy (Hasse and Storgaard, 2015), i.e. their ability to choose, use and evaluate specific technologies in the context of particular pedagogical approaches in given learning designs, was developed though experiments, theory and practice-based discussions with peers. The teachers became able to identify and formulate possible problem areas in their educational contexts, always with the central aim of creating motivating learning designs for the students.

The teachers and the principal found it motivating and effective to work in the ITP4T; it provided them with a new framework and the support needed to take responsibility for their own learning processes. The ITP4T experience showed that teachers and organisations must develop an understanding of the need to allocate resources for ideating and developing new learning designs involving the use of technology.

The relation between innovation and learning could be observed in the following processes. When the teachers found a satisfactory solution (a new innovation) for one of their stated problems or goals, at a later stage they could examine how they had arrived there, tracing the learning trajectory to their solution (Dewey, 1933; Weitze, 2015). By reflecting on their decisions during the collaborative design, the innovation turned into knowledge again, making the new learning design, the new learning process or the new way of sharing knowledge in the organisation possible to repeat. This new knowledge could then be communicated to other teachers in the organisation making the whole organisation benefit from these innovative processes.

The contribution of the ITP4T model is its ability to provide a theory-based learning design that supports a continuous practice and a structure focused on pedagogical innovation and reflection, with a foundation in teachers' and organisations' relevant professional challenges. This enables change and structured anchoring of the new concepts and may result in a visionary contribution to the educational institution.

The use of this new practice inside the VUC school empowered the teachers and created a new organisational learning design which could support innovation, help interrogate complex questions, create new organisational knowledge and anchor new knowledge and practices. These findings address the need for new knowledge in

this area (Hasse and Storgaard, 2015; Laurillard, 2012; Law et al., 2005; Somekh, 2007). The team practice gave teachers an identity not only as teachers but also as self-regulated learners, and the teachers had a more positive perspective of their own abilities to create change after participating in the workshops. In addition, the teachers valued the professional support they gave and received when developing new learning designs and when innovating together in teams. Though, the example presented in this section represents a small-scale design-based research experiment, the pace at which the teachers progressed through the issues and came up with pedagogical innovations indicated the great potential for use of the model in other new educational environments involving technology. The principles of the ITP4T have been developed into a course for master students at Aalborg University, where students are taught how to create pedagogical practices for teacher teams in their respective organisations. The intention is that this course will serve to impact prospective teachers and support them in becoming creators of pedagogical innovative teacher teams in their educational institutions.

Currently, six projects are taking place at various educational institutions in Denmark, using the ITP4T. These institutions include primary schools, vocational schools, Bachelor Universities, technical colleges and high schools/upper secondary schools. The humble hope is that the ITP4T model will inspire future teacher teams to innovate and learn together.

Example 2: Using a video-based platform for coaching

The second example relates to real-time coaching of teaching during classroom practice using web-based audio and video tools carried out as part of the MirandaNet

Fellowship research[3] undertaken on behalf of MirandaNet Associate, IRIS Connect[4], using their collaborative professional development system. This study is based on the findings from the first quantitative stage with one hundred teachers (Preston, 2014). This research shows that real-time coaching can generate a range of benefits and improvements. This example explores some of these benefits using short case studies of individual participants. Also explored is the wider context that needs to be established in order for these benefits to be realised with schools, teachers and coaches working in partnership to develop and improve best practice in a live school and classroom situation.

The involvement of the teachers as co-researchers meant that they have all been invited to comment on the data as a means of increasing knowledge sharing and ensuring participant validation.

The IRIS Connect video and audio capture technology has two components: the first is the LiveView camera system, which is used to observe and capture classroom activity and it includes an in-ear receiver so that the teacher may hear feedback and suggestions from the coach in real-time[5]. The coach is typically not in the classroom but observes the classroom activity through the video and audio feed (the coach may even be in a remote location beyond the school). The second component is the Discovery Kit, which is used to review and annotate the video data and recorded feedback. A significant aspect of the IRIS Connect system design is that all data is kept securely under the control of the teacher, not the school managers, senior teachers or the coach. The teacher controls the video data and coaching

[3] MirandaNet Fellowship (Mirandanet.ac.uk) at the Institute of Education Futures, De Montfort University

[4] http://www.irisconnect.co.uk/

[5] The LIveView camera is able to pan to the teacher because the teacher wears a special 'necklace' with a dongle that the camera can track.

feedback and decides what data will be examined, shared and discussed, and this is a crucial aspect of the effectiveness of this real-time in-ear video coaching.

Research design

The findings of the research reported here are based on interviews with six teachers (two female, four male[6]) who had been using the IRIS Connect web-based video system for at least 4 months and worked in schools where the use of in-ear coaching had been established for at least a year. The profiles of the teachers ranged from those who were just beginning in teaching to senior leaders who were well established in their profession and either learning to be coaches or already an experienced in-ear coach. The interviews aimed to explore the effectiveness of in-ear coaching and the professional working conditions that promote its effectiveness.

All the teacher interviewees were, in general, enthusiastic and positive about the value of in-ear coaching but also articulate about the potential pitfalls and risks. A key point that emerged is that the effectiveness of this method could not be divorced from the design, ethos and values of the school's CPD programme. What also emerges from the profiles of the interviewees is that there is a crossover between being a coach and being a coachee. The coaches do not set themselves up as the ultimate arbiter of good practice. Coaching is a joint enterprise that demonstrates the tacit agreement that, no matter how experienced, everybody gains from the coaching experience.

In the interviews, particular attention was given to those critical incidents that led the teachers to realise the value of the experience for their professional learning, anecdotes that might indicate a new direction, new idea or pinpoint learning. Critical incidents can illustrate how the experience might feel to teachers at different points in

[6] In this chapter we refer to the interviewees simply as Female A, Female B and Male A to Male D.

their professional lives and are used here to indicate how complex and varied human reactions can be to this innovative method of professional learning.

Case Studies

Interviewee (FA) was an early career teacher who felt herself fortunate to have had access to a wide and varied range of CPD, which was especially formative during her NQT year. The CPD process first required working with the coach to identify aspects of her teaching that she wanted to improve. Following each period of observation, she selected the video clips or 'reflections' she wanted to discuss with the coach.

Critical incident:

''One of my targets was the need to eliminate low-level disruption and to ensure that the pupils followed my instructions. At the time, I thought that the two targets that I had to tackle were very distinct. However, as the coaching session developed it became clear that the problem was not necessarily that my instructions were not clear enough. In fact the children were struggling to understand me. I was speaking too quickly and in a [strong regional] accent that few of the children had ever heard before. I immediately changed the way I spoke to the children ensuring that I spoke very slowly and enunciated clearly.''

Interviewee (FB) had in-ear coaching as an early career teacher when she was an English Subject Leader at an inner-city school with a high proportion of disadvantaged pupils, a multi-ethnic mix and a higher than average number of pupils categorised as Special Educational Needs (SEN) or entitled to Free School Meals (FSM). She found in-ear coaching valuable at the start of her career. As a result she is now learning to be a coach in her school where she is a senior leader.

Critical incident:

''I was struggling because my Think, Pair and Share routine was not being effective. The children were not working well together and there was low-level disruption. The in-ear coach suggested I asked the pairs to go knee-to-knee and eye-to-eye. The quality of the paired work rose exponentially. It was such a useful tip.''

Interviewee (MA) was a male internal supply teacher who had been going through 'a bad patch' in his career, beginning to wonder if teaching was the right job for him. The school was in special measures and has a high proportion of disadvantaged children with nearly 50% of pupils from disadvantaged backgrounds. As a young teacher with little confidence, he dreaded being observed. He remembers vividly his first observation using web-based video. He said, "*I felt pretty resigned by that time – whatever happens, happens*". However, the in-ear coach was encouraging because although he A felt he was a terrible teacher the review of his reflections encouraged him to realise that he was 'actually quite good at teaching.' That was a turning point:

Critical incident:

''I was in a bad place. The in-ear coaching saved my teaching career, but even further, had a big impact on my life. I am now so much more confident".

Interviewee (MD) is an experienced coach of several years standing, who reflected:

''The most powerful example I have done 5 times now: If the behaviour needs modifying, I've directed the teacher to have a child come to the coaching room and observe the lesson with the task of identifying the most effective and the most destructive learning behaviours of their peers. At times the child, facilitated by me, has coached the teacher… it's fascinating. When they go back to class, their behaviour is modified.

[…]

In-ear coaching helps a teacher to focus not so much on planning and performance but more nuanced reflection on how the class can be engaged. A lesson plan is important but with in-ear coaching the teacher's attention shifts to the effectiveness of the implementation. It stops being about delivering a lesson and becomes about teaching learners."

The teachers interviewed found the coaching process to be supportive, creative and, crucially, resulted in some significant insights into their practice leading to change and improvement. The teachers also enjoyed contributing to a face-to-face and online community of teachers who share ideas and support each other. One school leader commented:

''The long-term impact of web-based video I am seeing is that behaviour, thinking and language changes sustainably because of some well-timed comments from someone else in an in-ear coaching relationship.''

The willingness of teachers to learn and improve their professional practice is crucial to success. Trust is a key ingredient. The teacher must be in full control over all recorded video which is stored automatically into the teacher's individual user account on the web platform, protected by a personal password, and only they can decide if, when and with whom they might share their videos. This avoids any suggestion of surveillance and puts the teacher in control of their own improvement process.

One coachee tried to explain why the immediacy of in-ear coaching mattered:

''... the immediacy of the feedback – the relationship between how long after the session the feedback is given and its impact. If that is the case, extrapolating backwards, if you receive feedback at the exact moment you are doing something, then if that works this will be the most effective way to modify your behaviour, compared with the feedback that would happen in a post-coaching dialogue.''

Discussion

Several key points emerged from this study. Overall, all the teachers interviewed found the coaching process to be supportive, creative and, crucially, resulted in some significant insights into their practice leading to change and improvement. Much of the recognition of the practices that required attention also seemed to arise from the teacher's own review of their video observations and where these touch on personally sensitive issues changes in practice can meet with less resistance.

- A teacher moderating strong regional accent and the speed of delivery because she realised that the pupils could not understand her;
- A teacher recognising that an aggressive and negative tone was hindering behaviour and learning;
- A teacher realising that her use of assessment techniques was limited.

A further interesting aspect is how pupils can become involved in the coaching process. Inviting pupils to review video observations be more reflective about their behaviour in class, or inviting them to comment on what coaching advice they might offer to a teacher also led participants to comment on how they had learnt to respect their –pupils' own views about what is effective in the classroom.

The teachers had also enjoyed contributing to a face-to-face and online community of teachers who share ideas and support each other. One school leader commented:

> *"The value of the video platform is teachers can edit, share and comment to a range of people and then meet as a group to discuss a probe point – we look for one probe point within a reflection.*
>
> *The long-term impact of web-based video I am seeing is that behaviour, thinking and language changes sustainably because of some well-timed comments from someone else in an in-ear coaching relationship.*
>
> *The kids get used to it. But a sensible school will not use the system with pupils for whom it will not work: for example, autistic students who do not want to be filmed*'.

In-ear coaching cannot be used effectively to develop teaching techniques unless the teachers work out techniques for observing their behaviour in their own time. The willingness of teachers to learn and improve is crucial to success. Trust is a key ingredient. The teacher must be in full control over all recorded video which is stored automatically into the teacher's individual user account on the web platform, protected by a personal password, and only they can decide if, when and with whom they might share their videos. This avoids any suggestion of surveillance and puts the teacher in control of their own improvement process.

One coach who had tried to sign up all the staff in his first programme had experienced hostility from staff who were nervous about being observed and were afraid of the surveillance implications. He had had more success when he invited a small group of teachers to lead a change in the school CPD culture by signing up

voluntarily. They then became advocates for change in CPD processes. As a general model this approach may be the best way to introduce in-ear coaching into as school for the first time.

A general view was that a school that engages with web-based video in CPD should adopt a sample code of practice with their staff and also be prepared to change this code as experience and circumstances changed. A jointly developed code of practice should include clear principles about the ownership and control of data, that surveillance of teacher behaviour is not the purpose, that individual safeguard their own and others' data, that new uses of the tools should be agreed collectively, and that clear principles of transparency are adopted when the tools are in use in the classroom (i.e. that pupils are aware that in-ear coaching is being carried out).

Views about feedback were varied but what was valued was that each individual teacher can specify a different style of feedback related to the context and to their preferences and perceived expertise:

> *"It's an individual thing about how you like the in-ear feedback in real-time – you can give a signal when you want to hear feedback, e.g. when you feel you have no idea what to do next, ask the coach to help out. Everyone has different approach and style – it might be difficult for some people to change their teaching style on receiving the feedback but that was not an issue for me with in-ear coaching."*

One coachee tried to explain why the immediacy of in-ear coaching mattered:

"I have come across research that talks about the immediacy of the feedback – the relationship between how long after the session the feedback is given and its impact. If that is the case, extrapolating backwards, if you receive feedback at the exact moment you are doing something, then if that works this will be the most effective way to modify your behaviour, compared with the feedback that would happen in a post-coaching dialogue. The model we are looking at is this: the coached or observed lesson. Without video we draw on the different individual memories – both the observer and the teacher: with video it's a shared memory."

One coach and coachee partnership in this study invited pupils to be behaviour coaches and, feedback where trust is good and ethical considerations have been met, for even pupils to offer comments:

"Children are highly sophisticated individuals; they appreciate the fact that I am trying to improve. I ask them what has gone well what hasn't and they are positive about it and give their input".

Example 3: Developing tutors' metacognitive skills through the process of designing intelligent tutoring systems: LeActiveMath project

Our last example derives from the work undertaken as part of the LeActiveMath research project (henceforth LeAM), which was funded by the European Commission under the Framework 6 Programme[7]. LeAM is a system in which learners at different stages in their education can engage with mathematical problems through

[7] LeActiveMath was funded by the European Commission Framework 6 Programme, grant number: FP6-IST-2003-507826.

natural language dialogue. LeAM consists of components, which are typical within any standard Intelligent Tutoring System (du Boulay, *in press*). These components include (i) a learner model, needed to track learners' behaviours as they interact with the system to allow the system to infer whether and what the learner knows and is learning, (ii) a tutorial component needed to represent different aspects of the subject domain and the pedagogical approach to supporting learning within the domain tutored and (iii) an exercise repository and a domain reasoner, which enable the system to reason about the key elements of the domain and their various attributes, e.g. difficulty level of a particular type of exercise or different solutions that are available to a given problem. In addition to these key elements, LeAM also has (iv) natural language dialogue capabilities, which enable the system to select and deliver pedagogical feedback to the learner through natural language. LeAM's design is based on the premise that the context of a situation along with the interactions between learners and tutors are integral to both regulating learners' emotions and to recognising and acting on them in pedagogically viable ways.

To inform LeAM's learner and the natural language dialogue models, studies were conducted using a Wizard of Oz (WOZ) design methodology and a bespoke chat interface through which students and tutors interacted. WOZ is a methodology that emerged with the advent of computer technology and intelligent tutoring systems (Porayska-Pomsta et al., 2013). WOZ utilises computers' real-time data logging capabilities to capture moment-by-moment actions committed by users during their interactions with computers. The method is so called because its implementation typically involves a lightweight interface that can be manipulated by a human operator (the wizard) as if it were driven by artificially intelligent algorithms without the user knowing that they are in fact interacting with a human. The idea behind the

approach is that WOZ interfaces can be mocked up to resemble those of the desired fully functional tutoring systems, without involving the full cost of such an implementation. In the present example, the student-teacher communication channel was restricted to a typed interface with no visual or audio inputs to resemble the interface of the final LeAM learning environment that needed to be designed (see chat and history interface on the left-hand side of Fig. X). As such WOZ methods provide ecologically valid, contextually relevant means through which to evaluate some of the design and functionality ideas *a priori*. Importantly they also allow the designers of such technologies to elicit detailed knowledge from users (in this case learners) and experts (in our example – university maths tutors) needed to inform the design of technologies in terms of their functionality and prospective usability.

Five experienced tutors participated in the LeAM WOZ studies where they had to tutor individual learners in real time, delivering natural language feedback. They were told that the final goal of the study was to inform the specific components of the LeAM tutoring system, especially the user model and the dialogue model, which provided them with an overall frame within which to examine their own and their students' decisions and actions. The tutors were asked to talk aloud about their feedback decisions as they engaged in tutoring and to further qualify those decisions by selecting situational factors, e.g. student confidence or difficulty of material, that they considered important in those decisions. The tutors were asked to make their factor selections through a purpose-built tool every time they provided feedback. To aid them in this task some factors were predefined (based on previous research – see Porayska-Pomsta and Mellish, 2013), but these were not mandatory as the tutors could add their own factors to the existing set. The tutors could access and represent the situational factors through drop-down lists (see right hand side of Fig. 5), with

each containing fuzzy-linguistic values such as *very high*, *high*, *medium*, etc., each value reflecting a relative degree to which they believed a factor expressed the current state of the world. For example, the factor *student confidence* could have five possible values from *very high* to *very low*, with the tutor being able to add further values if necessary. This factor-value selection was used directly to implement the Bayesian network (both its structure and the prior probabilities therein), which was responsible in the LeAM system for performing the fine-grained situational diagnoses in line with those performed by the human tutors (see Porayska-Pomsta et al., 2008 for further details).

Students' screens were captured during each session for the purpose of replay and tutors' post-task walkthroughs, following each completed interaction. In post-task walkthroughs, the recording of the student screen, the tutors' verbal protocol, and the selected situational factors-values for the given interaction were synchronised to facilitate replay. Walkthroughs allowed the tutors and the researchers to view specific interactions again, to discuss them in detail, to explain their *in-the-moment* choices of factors, and to change their assessment of the situations. Any changes made during walkthroughs were recorded in addition to the original factors' selections.

The data elicited provided rich information about the relationship between tutors' feedback and the specific contexts that they take into account when diagnosing learners' cognitive and affective states. It also provided a concrete basis for the implementation of the user and dialogue models in the system and the corresponding knowledge representations. However, the studies also provided important insights into the potential impact that the *knowledge elicitation* process had on the participating tutors. Specifically, the demand on teachers to report on the situational factors of importance to their feedback decisions brought to their attention that such

factors may indeed play a role and forced them to think explicitly about them while making those decisions. Verbal protocols facilitated verbalisation of those decisions *while* they were made and later provided an important tool for facilitating situated recall. Although initially, all tutors had a clear understanding of, and an ability to identify the factors such as the difficulty of the material or correctness of student answer, they were much less fluent in diagnosing and explaining student's affective states.

Figure 7.5: Wizard of OZ dialogue and data collection interface used in Porayska-Pomsta, Mavrikis and Pain (2008) studies.

However, after an initial familiarisation period, involving up to two sessions, their willingness to engage in situational analysis and the fluency of their reports increased, while the tentativeness in identifying student behaviours at a fine level of detail seems to have decreased. This was evidenced in the increased speed at which they offered feedback to students, the level of elaboration in and the targeted quality of their verbal protocols and post-hoc interviews. For example, during the initial interactions, all of the tutors had their attention fixed on the correctness of students' answers, with the selection of the next problems or sub-problems to give as feedback to the students having been their chief concern. Initially, the tutors found it difficult (and at least 3 out of 5 of them even unnecessary) to pay attention to the language used by the individual students and to having to pay such persistently detailed attention to the different factors which were seemingly unrelated to the task of supporting learners in solving differential equations. Yet, on average, by the third

interaction, most tutors, save for one[8], began to verbalise explicitly their observations with respect to multiple situational dimensions such as content matter, students' possible cognitive states (e.g. confusion), emotional predispositions and states (e.g. confidence). The tutors were also able to identify reasons in the actual dialogue interactions for particular students' diagnoses, e.g. they reflected on some students using question marks at the end of statements as a potential sign of lack of confidence. Importantly, although the tutors were not burdened with having to understand the intricacies of the formal implementation intended within the LeAM system, i.e. the Bayesian knowledge representation and reasoning that was eventually employed to capture the dynamics of the situational diagnoses, having to represent their selections of situational factors in terms of the degree to which they believed those factor-values to be manifest in learners' behaviours highlighted to them the nuances in individual situations' and learners' idiosyncratic needs in the face of seemingly the same learning challenges and/or student misconceptions. This was reflected in the tutors' feedback to the learners, which over time became more positive, more elaborate, and more targeted to the actual factor diagnoses made than was the case initially. This was especially visible with respect to partially correct situations, in which some tutors (3 out of 5) made increasingly consistent effort first to provide praise for the correct part of the answer, e.g. "*This is so nearly right. Maybe you can spot the mistake before I send the right answer…"* or encouragement, e.g. "*You are doing well up to now..."* (for details of the analysis see Porayska-Pomsta et al., 2008).

The use of verbal protocols during the interactions, followed by semi-structured interviews, and then post-task walkthroughs provided tutors with an

[8] This tutor found it difficult to accept that her reporting on what, how and why she was doing in this context was not intended to evaluate her as a tutor, but to learn more about the tutoring process more generally.

opportunity to first formulate and record their diagnoses of the student in context, then reflect on and finally re-examine them. The post-hoc walkthroughs allowed the tutors to assess the consistency of their interpretations and further, to analyse those situations where they did not agree with themselves, leading, according to some tutors, to deep reflection and grounding of their understanding of (a) what matters to them the most in tutoring situations and (b) the kinds of tutoring they would like to deliver *ideally*. At the end of the study some tutors expressed a need for a tutoring system for tutors, through which they could rehearse, experiment with and perfect their understanding of the different nuances of educational interactions, showing a real appreciation of the value of having to explicitly go through the effort of externalising, explaining and critiquing their practices.

Discussion and Conclusions

In this chapter we presented three examples of the use of technology for supporting educational practitioners in developing their adaptive metacognitive skills and pedagogical expertise. The technologies discussed through the three examples differ in terms of their respective functionalities as well as their application and fit to the different contexts of use.

The first example discussed the utility and the application of the video conferencing tools in combination with a well-defined framework for collaborative reflection and problem solving by teachers working in further education. This example illustrated both the feasibility and the value of using a well-defined framework (ITP4T) as a means for scaffolding self- and collaborative reflection by teachers. Providing teachers with such a framework helped them articulate and share with other practitioners the pedagogical challenges that they faced daily. Such strictly

scaffolded process over several design and reflection cycles, led to teachers developing a common language and familiarity with a routine of co-creation and collaboration with others. Both the language and the routine provided the necessary tools for expression, indepth reflection and introspection. While the process allowed the teachers to explore and experiment with the different solutions, it also highlighted the importance of explicit articulation and sharing of the challenges in a collaborative context where solutions could be co-designed by other practitioners. The ability of educational practitioners to share their professional challenges and solutions has been highlighted by Lin et al. (2005) as being critical to engendering pedagogical innovation. Comparison of perspectives through a carefully scaffolded process and the social aspect of such comparisons seems key to helping practitioners to shift their gestalts, to observe and then in turn be able to generate novel solutions to the specific challenges, leading them to more in-depth questioning, while also increasing their willingness to innovate, experiment and reinvent what they do. Furthermore, having other practitioners to position themselves against one's perspective may also help evaluate the potential effects of acting in particular ways. Identification of missing information and whether/why it is needed to clarify challenge situations may help educators in diagnosing them in tangible terms. Such identification can be accomplished through sharing perspectives with other practitioners and, equally, it can serve as a basis for sharing different points of view. Either way, it can help practitioners make informed decisions with respect to diverse possible actions that address the particular challenges, while also allowing them to contemplate the possible consequences of those actions.

In the second example, we presented case studies of teachers being coached by a human expert while teaching through an in-ear device. This coaching was intended

to draw the individual teachers' attention to the potential areas for improvement in their practice. The *in situ* element of the coaching offered a unique opportunity for (i) delivering immediate and contextualised feedback that the coached teachers could instantly put into practice, (ii) the promotion of reflective practice and ultimately sharing of practice across and between schools and (iii) an opportunity for pupils to become more reflective about their own learning and behaviour. As has been already discussed in the introduction the timing of the reflections has been highlighted by Hewitt et al. (2003) as key to facilitating the development of adaptive decision-making and metacognitive competencies by teachers. However, although Hewitt et al. emphasised the importance of immediate post-hoc introspection, this second example provides a powerful case for the value and feasibility of real-time self-monitoring and professional self-regulation. Nevertheless, the caveat is that the participating teachers need to know from the outset that the system will not be used as a means of surveillance or assessment of capability and that the whole process is based around teacher control and empowerment. Since the professional development landscape is becoming increasingly more fragmented and localised (Pachler et al., 2011), this technology provides a platform that teachers themselves are using to share their practice internationally in order to improve their practice.

The third example illustrated how knowledge elicitation methods derived from and used in Artificial Intelligence research can also serve to support educational practitioners in articulating, reflecting on and improving their practices. The LeAM technology demanded knowledge about moment-by-moment decisions made by university maths tutors in a tutorial interaction with students. Of particular interest here was the relationship between tutors' observations of specific situations, including their interpretations of students' motivational and emotional states and their feedback

decisions. In line with the first two examples, the process of tutors' reflection and self-reporting was aided through a strictly controlled means involving a bespoke interface designed especially for this purpose. Similar to the other examples, tutors' access to the recorded interactions and the fine-grained detail of self-reflection along with the permanent trace of those self-reflections that was afforded by the technology used proved invaluable to teachers increasing their self-understanding and self-monitoring during tutorial interactions.

All of the examples show that an investment in teachers' metacognitive competencies leads to their ability and willingness to inspect and improve their professional practices. All examples make a strong case for a need to develop formal frameworks, reflective routines and communities of practice within which educators can engage in reflection and where their thinking can be accomplished. Such framework should scaffold the practitioners in identifying first *what* it is that they think about the specific challenge situations before helping them to determine *how* they think. All examples and case studies presented illustrate some ways in which this could be achieved and this is further supported by examples from other studies such as by Hewitt et al. (2003), Lin et al. (2005).

Use of multimedia and multimodal access to the learning situations (e.g. as in LeAM's synchronised WOZ interface) are important for anchoring practitioners' reflections, but they have to be coupled with active and targeted questioning as shown through the ITP4T framework introduced in this chapter's first example, with comparison with the perspectives as well appropriately timed opportunities for reflection and experimentation (second and third example), in order to be effective.

All of the examples along with the literature reviewed suggest that with appropriate set ups and willing practitioners their adaptive metacognition and

professional decision making competencies can be developed into innovative practices in real educational contexts. Studies by Hewitt et al. and Lin et al. seem to corroborate these conclusions showing that teachers' established and long-unquestioned points of view can be changed through careful scaffolding, that pedagogic creativity can be fostered by exposing educators to different perspectives and that the two can serve to elicit indepth, explicit descriptions of what the practitioners consider best practice in specific contexts. Although the sustainability, efficacy, and scalability of such practices is still an open question, research points to the need and value of rethinking what we consider to constitute educational practitioners' expertise and the investment that we make in supporting the development of educators' adaptive decision making and metacognitive competencies.