What teachers know

Final report on AHRB project:

Attention and the Knowledge bases of expertise

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1 introduction

The project offers an innovative conception of expertise and applies this to a pilot study of the expertise of experienced classroom teachers. The key idea is that a good part of what experienced teachers know is knowledge that is contextualised and attention-dependent. This is knowledge available in situ given the operation of specialised attentional skills. Not only does this knowledge not get written down in lessons plans, but it could not be written down in lesson plans. Such knowledge concerns both the cognitive and affective aspects of classrooms. Instances of this knowledge provide intentional states - beliefs, desires, purposes, etc. - that are both attention and environment dependent. The content of such states depends both on the active attention of the subject and on the nature of what is going on around them. These states then both causally explain and justify the resulting behaviour.

An image helps to throw the conceptual innovation into focus. On the traditional conception of action explanation, knowledge figures in the explanation of performance as an element of the causal antecedents of behaviour. Expert knowledge involves having sophisticated general theoretical knowledge among the causal antecedents of behaviour. On this traditional model what the expert knows can in principle be written down in advance of performance. That is the model typified in expert systems approaches to understanding expertise.[1] Our model presents an alternative image. It is the image of the expert as someone with a specialised set of attentional skills. These provide the means for coupling with particular situations and features of the environment. These couplings, or hooks, act as regulators for behaviour rather than its causal antecedents. Couplings with the environment act as attractors for the ensuing behaviour. The agent is literally hooked up to the environment in ways that regulate their behaviour. The expert classroom teacher is not working to a theoretical rule in determining performance; they are working to achieve a balance to the various attractors that at any one time arise in virtue of their capacities for attending to the particularities of the situation.

The model supports a kind of particularism about expert knowledge and deliberation. Knowing what to do comes from attentional coupling with particulars rather than appeal to a general rule. The conceptual heart of the model is the hypothesis that attention-dependent

knowledge about particulars has a role to play in justifying or rationalising expert performance. What makes someone an experienced teacher concerns their abilities for attending to particularities, not their retention of general rules. For this idea to do real work, attention to particulars must both causally explain and justify behaviour. When this is the case, we call the operation of such an attentional skill *insight*. Our central conceptual innovation could then be summarised by saying that what the experienced teacher possesses is a set of attentional skills that provide insight. This is the capacity to see what to do and why it is the right thing to do on the basis of an attentional coupling with the particularities of the environment.

In the discussion of particularism in ethics, particularism is normally contrasted with generalism by saying that the key to uncovering one's ethical reasons comes from close scrutiny of the particular situation rather than a comparison between the particular case and other cases in the attempt to find a general ethical rule. Dancy expresses this by contrasting the activity of 'looking at' as opposed to 'looking away'.[2] But given that insight or 'looking at' has to provide a reason for action, it is unclear how this can be so unless there is some pattern to the reason uncovered by insight. The normative idea of knowing the right or rational thing to do on the basis of attending to the particular requires some notion of patterning to behaviour.[3] Without some patterning, the very idea of 'the rational thing to do' would be a primitive, a sort of Humean bare existent.[4] It is simply unclear that that makes sense. The key conceptual challenge for our model is then to make credible sense of the idea that quality performance - something that has some normative backing - can be based on attention to particulars rather than derived from general rules. The concept of insight must pick out a real source of normativity for expert performance without reducing to a shorthand for merely nifty deployment of theoretical knowledge? We need to acknowledge that there is a shape or pattern to insight, but not a pattern that derives from theory. The patterns of good reasons and expert deliberation about what to do are then both caused by and justified by attention-dependent coupling with particular situations. These are cases of insight. In the next section we lay out the conceptual moves necessary to make sense of insight.

2 understanding insight

The key to understanding the concept of insight is the concept of attention. Insight is an attentional focussing on a particular, or particular scenario, that both causally explains and justifies the resulting patterns of behaviour. Insight is not just nifty thinking. The idea is not the familiar empirical point that learning can involve a capacity for rapid response and working out what is required to behave rationally. The point is the conceptual claim that the source of the normativity of acting and thinking well lies in singular cognitive states of attention. If this is right, then any adequate account of learning, let alone learning that underpins experienced teaching, will have to accommodate the learning of insight.

   For the idea of learning as the development of insight to be interesting, the concept of attention has to deliver a conception of singular cognitive states that not only causally explain, but also justify the resulting patterns of behaviour. The cognitive states that play this role are states expressive of singular purposes. In order to see how they can play the dual causal and justificatory role required, we need to start with some basic ideas about singular belief states. Singular purpose states inherit their justificatory role from key features of singular belief states. We shall concentrate on the justificatory role of singular cognitive states, for this is the most contentious part of the theory.[5] Without an account of the justificatory role of singular cognitive states, the theory would be open to the objection that attention-dependent states were at best causally significant in explaining expert performance. That would leave it open to insist that it is theoretical general knowledge that is constitutive of thinking and acting well, for it is general knowledge that sets the standards of what it is to think and act well even if it is not that which happens, in many cases, to be causally productive of such behaviour.[6]

2.i singular cognitive states

The simplest example of a singular belief state is a perceptual demonstrative belief about a physical object, e.g. the belief 'This is white' with respect to a perceptually presented object. Such states are relational belief states. They are states the content of which is both subject and world dependent. The belief state involves a way of thinking of the object that is only possible given the subject's perceptual orientation to the object. You cannot have a 'this' way

of thinking of an object unless the object is there for you to pick out in perception. Similarly, a 'this' way of thinking of an object is not possible without a subject paying attention to the object. Paying attention to an object makes available a way of thinking of it that is not otherwise available. Attending to simple physical objects is a common competency, something that all normal human subjects acquire. Such attentional skills make available to a subject singular beliefs about the particular objects that attention focuses on. These are regular beliefs in so far as they are items subject to the normal conditions for truth and falsity. They are, however, beliefs such that their truth conditions are intrinsic to their individuation. The condition under which the perceptual demonstrative belief 'This is white' is true turns on whether the demonstrated object is white, but the demonstrated object is constitutive of the individuation of the belief. The account of the very content of the belief depends on the existence of the object implicated in an account of the belief's truth conditions. When one is in such a belief state one is, therefore, in direct calibration with that which is constitutive of its correctness condition. In such beliefs one is directly coupled with that which provides the standards of correctness of the belief. To have such a belief is to have a direct coupling with that part of the world that makes the belief true.[7]

This notion of a singular belief in which one is directly coupled with that which provides the standards of correctness of the belief introduces a key idea necessary for the justificatory role states like this play in rationalising behaviour. Consider a singular purpose in a simple case of a cricketer catching a ball. We might ask why the fielder ran across the field, to which their obvious answer is, 'I wanted to catch that ball.' This is singular statement of purpose. It picks out demonstratively a particular object attention on which provides the control on behaviour. It is such singular purposes that can both explain and justify behaviour and they do this because of the way in which they provide direct couplings with the environment.[8] It is the capacity to keep one's eye on the ball that explains the production of the ball-catching behaviour. That capacity to attend is a capacity to couple with the environment. It is attention then that does the explanatory work in producing ball-catching behaviour. It provides the singular cognitive state that is causally productive of successful ball-catching. Where the singular cognitive state is a singular purpose, it also justifies the behaviour by figuring in the account of what makes it rational.

2.ii The justificatory role of singular cognitive states

We treat the issue about justification by focussing on the question of whether or not there is a theory that underpins competent performance such that the subject who learns how to perform well does so by acquiring a theory that explains and justifies their action. If singular cognitive states justify behaviour, their role must be more than merely nifty causal short cuts that explain behaviour.

So, consider again the ball-catcher. Is there a theory of ball-catching? On the face of it, it would seem not. There is, of course, a rich background theory about the sorts of trajectories different kinds of objects take under various conditions. There are general statements relating the importance, for ball-catchers, of positioning themselves at or about the point where a ball in flight will come to earth and lots of rules of thumb about where to field when defending against a left-hander facing a leg-break spin bowler, etc. And there are the *a priori* abstract theories of logic, probability, decision theory, etc. that characterise the optimum way of employing all this theoretical information. But consider a cricket fielder who has acquired all that theoretical knowledge. Does that make them a good ball-catcher? The answer is surely 'No'. It is, of course, important that they grasp the value of catching balls in cricket and that they rate this as an important goal when in the field. But if that theoretical knowledge is all that they know when they take the field, we cannot anticipate much by way of thinking and acting well on their part. What they need, in addition to theoretical knowledge, are capacities for attending to the right sort of aspects of play.

Suppose then we have a fielder who, in addition to the general goals and values of cricketing also possesses the attentional skill for coupling with balls in flight. What is it that rationalises their behaviour? What is it that provides the normative force to the rationalisation of their behaviour? We suggest that to both questions, the best answer is the singular purposes we ascribe to the subject in explaining their behaviour. In answer to the first question, if we are not sure why the fielder suddenly turns to run to the outfield, it is enough to know that he wants to catch that ball. Citing such singular purposes is, often enough, all that needs to be said to provide a rationalising explanation of the behaviour. The second question asks for the source of the normative force of such a rationalising explanation.   So, citing the

singular purpose rationalises the behaviour, it gives us the reason why the fielder acts as he does. What makes this a good reason?

The simple answer to this question is that the singular purpose is a good reason, it carries normative force, simply in virtue of it being a purpose by which the subject couples his goals to the world. It is a purpose by which the subject fits his projects to the world. There is no need to see the normativity of this reason grounded in the way that it is subsumable under a more general theoretical framework. The normativity of behaviour is grounded in the way that the singular purpose couples the agent to the world. In making this suggestion, we are assuming that the question about the normative force to the rationalisation has two possible answers. One answer is to see the normativity of the reason grounded in a wider theoretical framework where that framework exhibits a pattern deemed normative by abstract theories whose normativity is knowable *a priori*. On that approach, the normative force of saying 'I want to catch that ball' derives from the way in which that purpose embeds within a larger structure of reasons (beliefs, desires, purposes, etc.). The alternative is to account for the normative force of this reason in terms of its coupling of the subject with the world. The singular purpose ought to be listened to simply because it couples the intentional profile of the subject with the world. The subject's profile of beliefs and desires gets to be rational because it is in touch with how things are.

The clear reason in favour of this approach concerns the sheer implausibility of the idea that the normative force of 'I want to catch that ball' is grounded in the way this purpose is subsumable under a theoretical structure of good fielding purposes. There is no such structure. This is not to say that when one formulates such a singular purpose under very particular circumstances one's purpose is not generalisable. If under such-and-such specific conditions it is appropriate to run 130° from the batsman's orientation then, for sure, should such-and-such specific conditions obtain again and everything else is equal, then one should again run 130° from the batsman's orientation if one's aim is to catch the ball. But to acknowledge that one's attentional take on a particular circumstance exhibits that sort of generality is simply to acknowledge that it is a condition on some belief, desire or purpose figuring as a reason that there be a pattern to the way it engages with other beliefs, desires, etc. It is the point that there is a shape to insight. When we see the normative force of the

reason this is not a bare existent. That there must be a pattern to a reason's engagement with other intentional states falls short, however, of the idea that such patterns can be articulated into a theoretical regimentation of how to run around a cricket pitch and catch balls as an effective fielder. The performance of the competent fielder will be patterned. That is a condition on our finding the performance capable of rational explanation. But the normativity of the performance turns on the performance meeting the singular purposes from which the patterns emerge, not on the performance fitting the pattern. The pattern is a consequence of the purpose, not the other way round. Where our singular purposes put us in touch with the world, then the normativity of the behaviour is literally grounded in our fit with the world.

The cricket fielder takes to the pitch with a large backdrop of knowledge that can be represented theoretically: their understanding of the rules of the game, their general purposes to get the other team out, reduce their run-rate, etc. The experienced fielder takes also a repertoire of attentional skills by which they literally couple with the environment in the singular purposes such skills provide. The skilled patterns of behaviour that characterise the experienced fielder emerge from the interplay of the theoretical background and the various couplings that attention holds in place throughout the game. There is no scope for articulating the knowledge delivered by these couplings into bodies of theoretical knowledge from which the ensuing patterns of behaviour can be derived, for the patterns of behaviour are as particular as the configurations of couplings that give rise to them. And those are potentially unique. What is repeatable is the attentional skill, the capacity for coupling, with which the fielder takes the field. The knowledge it delivers that shapes and justifies behaviour is particular.   Without the background knowledge, the coupling of singular purposes would make little sense, they would lose the background motivation for wanting to catch balls that they pick out by attention. Without the attentional skills, they would take the field as walking textbooks with no capacity for engaging rationally with what is going on. That engagement is insight.

The point about the cricket fielder could be expressed like this. Suppose a particular fielder is meticulous in their game planning. They write down extensive plans for how they think they should behave when on the field. They produce complex analyses and reflections on their performance. If the thought that learning is as much about acquiring insight as theories is

right, then it is not just that, for any given game, there will be much that the fielder does not write down in his game plan, there will be much that he cannot write down. Much of the competence of the performance will be due to his deployment of insight to deliver singular purposes in the dynamic of the unfolding of the game. Applying this model to the competencies of experienced classroom teachers is relatively straightforward.

2.iii experienced teachers

The model suggested is one in which a significant component of the learning that makes someone an experienced teacher is the acquisition of attentional skills that provide them with insight. This is the repertoire of skills deployed when the teacher adapts their teaching in response to the particular cognitive and behavioural situations any one particular configuration of pupils present in a given lesson, in a way which could not have been planned in advance. Their insight draws upon repeatable capacities for attending to certain types of cognitive, emotional and behavioural situations and thereby seeing what is required, in the light of background educational goals and learning tasks, to engineer a quality learning environment. Such a way of thinking about the competencies of experienced teachers shows that what matters for good teaching is not just the general purposes and goals recorded in the lesson plan. What matters are the singular purposes that arise from trying to respond to this need, that disturbance, this innovation and that insight from the pupils.[9]

The experienced class teacher who has learnt expertise, like the cricket fielder, will be able to reflect on and articulate general goals and values that structure the broad shape of their teaching. These might include high level theoretical ideals. But all these things at best set no more than the outer parameters for good teaching. Knowing these sorts of things does not make you an experienced teacher. It is only when you have acquired insight that you have the capacity for responding to the particularities of classroom environments in the way that most experienced teachers recognise as expertise. There really is such a thing as experiential wisdom. It is what we call insight.

Insight can be studied. Our pilot was an empirical study of the ways in which experienced teachers adapt to the particular demands and opportunities presented to them by the pupils in their class. The task was to identify the different types of moments in experienced teacher

thinking when their decision making relies more on insight than on the application of the rules and principles that figure in the lesson plan. Competent teaching will always involve elements from both sources of knowledge, but the teacher without insight will be like the cricket fielder who takes to the field as a walking textbook. They will do fine just so long as the pupils before them behave exactly as predicted in their lesson plan and exhibit a thoroughly standard learning curve in coming to grasp the concepts, procedures and knowledge that the lesson covers! That, of course, seldom happens.

The suggestion that the concept of learning as the acquisition of insight applies to the learning that informs the competence of experienced class teachers can still seem a limited application of the idea. It is a limited application if you assume that the learning of pupils in class is chiefly concerned with a knowledge transfer from teacher to pupil, an acquisition by the pupils of theoretical knowledge presented to them by the teacher. On that restricted conception there would still be need for teachers with insight, but the role of insight on the teacher's behalf would plausibly be restricted to use in overcoming problems and obstacles to the pupils' theoretical learning. The need for teachers with insight would be no more than a function of the fact that the sorts of difficulties, both cognitive and behavioural, that one encounters in the classroom cannot be predicted. Insight would be required as the resource for handling the uncertainty endemic to pupils' learning needs. Pupils present with novel particular obstacles to their learning. It takes insight, not theoretical rules, to manage these problems.

Suppose, however, you assumed that the learning of the pupils also involved insight. Suppose, that is, you thought a central aim of the education system was to equip pupils with the sorts of cognitive skills characteristic of experts, to treat them as apprentice experts with the capacity for attention and insight.[10] On that assumption, the nature of the classroom environment is radically changed. Its natural condition is one of a degree of uncertainty as teachers with insight work to generate the active attention of insight in pupils. On the assumption that learning as the development of insight has a more general application, the need to view expert teachers as subjects with insight is no longer a function of the obstacles that classes can present to learning, it is a function of the general nature of learning. On this conception, a key focus of enquiry will be not only the role of the teachers' attention in

determining behaviour, but also the way that this integrates in exercises of joint attention with the pupils. A key task for the experienced teacher will then be the interrogation of pupils' attention and adapting behaviour of themselves and pupils to produce activities of joint attention.

3 the empirical study

3.i developing a methodology

As a first approximation, our approach was to watch some lessons, identify the 'interesting episodes', and then interview teachers about them. The remaining sections of this paper discuss the development of our methodology from this starting point, and present some initial findings. We have worked broadly using a grounded theory approach. Although data collection and analysis are described separately here, they were, to some extent, interwoven during the project.

The study was carried out with a group of experienced teachers, two teaching Y6 in a primary school, and 4 teaching mathematics in secondary schools. This was an 'opportunistic' sample as the teachers were already involved in another project lead by one of the research team. Amongst other advantages, this meant that they knew and trusted one of the researchers, and were used to having observers in their classrooms.

There were two cycles of observations. In each cycle one mathematics lesson (and occasionally two) from each teacher was observed and recorded, using a video camera and a radio microphone. The lessons to be observed were chosen by the teachers, generally on the basis of convenience. We had no preference in terms of the age group or topic we saw, and hoped to see 'typical' lessons, rather than ones prepared for our benefit. We did not ask the teachers to give us written lesson plans, as this would have imposed a level of formality which we wanted to avoid. Wherever possible we had a brief discussion with the teacher about their plans immediately before the lesson.

As often as possible, all three members of the research team were present, one operating the camera, and the other two making unstructured observation notes. The audio tape was transcribed in full straight after the lesson, and later the transcripts were annotated to add in non-verbal behaviour and contextual detail. The aim of the observers in the lesson was to identify episodes in which the teacher appeared to be acting on the basis of attention to aspects of the classroom activity, rather than in ways which could have been predicted from a lesson plan. Clearly there could be very many instances of such behaviour in any lesson, since even the most detailed lesson plan will not specify the exact words to be spoken, or the

pace and nuances of speech. Our observations needed to focus on relatively 'big' incidents that were accessible to observers as the lesson progressed. Typical examples of potentially interesting episodes were:

> when a pupil was unable to answer a teacher's question,

> when a pupil gave an answer which was clearly unexpected,

> when a pupil asked for help, or was clearly confused or inattentive,

> when a teacher appeared to change the pace or direction of the lesson,

> when a teacher reacted to, or ignored inappropriate behaviour.

Immediately after the lesson, the researchers exchanged initial impressions about the episodes they had observed. A couple of days later, the researchers met to discuss the lesson in more detail, with both the video tape, and the transcript of the audio tape available. They used their respective notes to identify the episodes in the lesson that would form the focus of an interview with the teacher, which took place immediately after this discussion.

The relevant sections of the video tape were found and marked for each episode. When the teacher arrived, an informal interview was structured around watching the video sequences. Each interview was audio taped, and a full transcription made. Because of technical difficulties, some recordings were not clear enough for transcription. In the end, a complete set of data (observation notes, video and lesson transcript, and interview transcript) was collected for ten lessons. The transcriptions of these lessons and the related interviews were subsequently coded (in Nvivo), using codings which emerged during the data analysis.

3.ii developing the approach to data collection

The key features of our methodology were the researchers' ability to identify the kinds of episodes that we were interested in exploring as the lesson was in progress, and developing an interview strategy that would enable the teachers to talk about their actions during those episodes.

Identifying potentially interesting episodes involved speculation about what had prompted a particular action. We were creating stories about what we had observed, and inevitably our stories were a function of our attention during the lesson. Initially, there were some interesting differences in the ways in which each of us attended to the progress of the lesson, which we

might attribute to our differing professional backgrounds. Re-viewing parts of the lesson through the video recording was therefore important in our identification of episodes. As our experience of the individual styles of the teachers increased, and we developed a clearer picture of the kinds of episodes which were proving interesting, there was an increasing level of agreement in the examples we identified as worth exploring at interview.

During the interview, one of our concerns was to test out our stories about the episodes. In some cases they turned out to be mistaken: what we took to be a spontaneous decision had actually been planned, or the interaction with a particular child was based on previous history of which we were unaware. In other cases, the teacher did not have particularly clear recall of the episode, even having seen it again on the video. In these instances, it was always tempting to tell our own stories to the teachers, and this clearly influenced what they might say. In order to maintain a more neutral approach, the technique we adopted was for one researcher to provide the basic structure of the interview, setting the scene for each video extract, and using an opening question such as 'What's going on here?'. The second researcher then brought in different questions to try to probe the teacher's thinking further. Productive questions which emerged were:

> If you could run that lesson again, would you change anything?

> Can you think of a similar occasion when you have acted in the same way/differently?

> Is that a common strategy for you to use?

Without exception, the interviews were relaxed occasions. As they became more familiar with our style, the teachers often offered spontaneous comments in response to the video extracts. All the teachers seemed to enjoy the opportunity to discuss their pupils and the content of their lessons in this way.

3.iii analysing the data

Our first attempts at analysing the data focussed on the episodes themselves, based on the lesson transcripts, the observation notes and the video recordings. We coded contextual details (e.g. whether the episode involved an individual, group or the whole class, whether it was initiated by teacher or pupils), and the underlying focus of the episode, as *cognitive* or *behavioural/affective*. The vast majority of the episodes we identified were cognitive, and we

sub-divided these into *cognitive problems*, where pupils were showing differing understandings of mathematical ideas and the teacher was trying to address this, or *cognitive opportunities*, where the teacher was trying to extend the pupils' thinking.

A second kind of coding of the episodes was to distinguish between occasions when the teacher seemed to be *reacting* to the classroom context by using a familiar strategy, and those when the teacher was *responding* in a novel way. The distinction between reactions and responses was not, however, always clear-cut.

A further coding was to indicate whether, at interview, the teacher seemed to have been aware of making a (conceptual) choice in that particular episode, or whether their reaction/response had been more intuitive (non-conceptual). Because the clarity with which teachers seemed to remember the lessons varied, this distinction was also not always straightforward.

The interview transcripts were initially coded in fairly pragmatic ways, using a range of codings to indicate both the kinds of things the teacher was saying (e.g. talking about their history with a particular child, referring explicitly to their planning), or the kinds of questions they were answering (e.g. what they might do if they could be 'parachuted' back into the lesson).

More detailed analysis of the interview transcripts provided some clear evidence that teachers were acting, in part, on the basis of attention-based knowledge. Their accounts contained references to (for example) the expression on a particular child's face, a sense of restlessness in the class as a whole, an interaction they had observed between particular children. Further, it emerged that a feature of many of the episodes was that the teacher talked explicitly about what they thought underlay particular actions on the part of the pupils. Our most recent analysis of the interview data has therefore identified sections of the teachers' accounts that indicated that their attention had been focused on what pupils' were attending to. Where the focus of the episode is cognitive, it is almost always the case that pupils' attention is not, initially, on what the teacher had intended. This particular form of attention-based knowledge – knowledge about the pupils' attention – seemed to be particularly significant in episodes in which we saw teachers moving the mathematical content of the lesson forward.

The significance of this aspect did not emerge for us until after the data collection was completed. For some episodes, the interview transcript provides evidence for this kind of attention. For others, there is nothing explicit in the transcript. This may be because the teacher was not, in fact, attending in this way, or it may be that the structure of the interview did not support discuss of this. It would be a priority in future research to adapt our interview technique to try to elicit such commentary, for example by asking 'Did you have a sense of what the pupils were thinking about?'

The episodes for which the interview data provides evidence of the teacher attending to pupils' attention include both ones which we categorised as cognitive, and as affective, and more surprisingly for us, included both responses and reactions. This led us to a further analysis of episodes in which the teacher is attending to pupils' attention. In some the teacher appears to be *interrogating* the mismatch between the pupil's attention and the teacher's expectations in a way that allows the teacher to adapt their teaching to move towards shared attention. In others, although the teacher is clearly *noting* the pupils' attention as different from their expectation, they do not work directly on this difference, but use some other strategy.

4 a snapshot of data

To give a flavour of the data we have collected, we offer three brief examples. The first is taken from a Y6 class. Jenny has asked Colin a question that he is unable to answer. After looking at him for a few moments she says 'Not sure? Don't worry' and then asks another child (Hilda) to give the answer. Later Jenny to returns quietly to Colin and asks if he has understood Hilda's explanation. At interview, Jenny described her reactions.

Jenny: It's Colin. He doesn't know. Oh, love him. … Again, he's incredibly lacking in confidence. …. Urm, I don't know why I didn't keep going with Colin but I didn't. I went to Hilda and got her to do it, didn't I? And then I went back to him. I didn't want to leave him without knowing what to do, but I didn't want to draw attention to the fact that he didn't know. …

Int: … what we are interested in was what it was you were picking up on that made [that] feel right ...

Jenny: I suppose it was that I could sense a sort of panic in Colin that I didn't want to make worse. And yet I banked on Hilda knowing it. I just knew she would be fine and she'd be able to do it. So I could reinforce it for everybody at that point and then I could go back to Colin and ease that worry that he was having.

We categorised this episode as *Cognitive problem, Reaction, Non-conceptual, Noting*. Jenny reacted to Colin's 'rising panic' intuitively by using a familiar strategy of asking another child to help out. She was able to note Colin's difficulties, both cognitive and affective, it was not possible, at that moment to work with them to support his thinking.

    The second example is from a Y7 lesson on quadrilaterals. The class have been playing a matching game with shapes, and Alice has realised that they are not as familiar with the vocabulary as she anticipated. The class have identified some of the shape names they find difficult and Alice has collected a list on the whiteboard (Parallelogram, Isosceles right angle triangle, Scalene triangle, Rhombus, Quadrilateral, Arrowhead, Isosceles trapezium). Alice's first strategy is to eliminate the two names for triangles from this list so that she can focus on quadrilaterals.

Alice: Let's look at these words on the board then. I know you've met some of
           these words last year and you've probably forgotten what some of them
           were. There are two words on there that don't fit with the rest. Can you work
           out which of those two words don't fit with the rest? Tod?

Tod: Rhombus and arrowhead?

Alice: Why do you think that?

Tod: Well, they don't seem like regular shapes.

Alice: They don't seem like regular shapes. Ok. Could be rhombus and
           arrowhead, but that's not what I am looking for.

Ellie: Is it rhombus and arrowhead because they're not like - they're not like a
           certain shape.

After getting one or two more responses, Alice changed approach and focused on each item
in the list in turn, asking pupils to describe and draw it. At interview Alice spontaneously
made the following comment:

       I had no idea what it was that [Tod] was trying to say. I couldn't see any link
       between the two he had given me. I couldn't think, arrowhead and rhombus? What
       are the … Apart from the fact that the words themselves may be as opposed to the
       shape. And I had no idea. And when the next person said the same two things, I
       was beginning to think: Oh God! There is something I am missing here. [Laughter]
       Something that is obvious to them but not obvious to me. Because you know
       sometimes with child's eyes you see something. Then I realised that they obviously
       didn't even look at those words and think, oh that's a three sided, that's a four sided.
       They obviously didn't have that connection as an obvious connection between the
       number of sides and the actual words. There was obviously something else they
       were looking at, if you know what I mean. Which is why I then thought I am going to
       have to try and pull out here how many sides do these things have.

We categorised this episode as *Cognitive problem, Response, Conceptual,*
Interrogating. Alice recognised a mismatch between the pupils' focus of attention and

her own, and was able to interrogate this in order to respond in a way which changed the direction of the lesson, but enabled her to re-focus the pupils' ideas.

The third example comes from a Y7 lesson in which pupils are practicing their skills with using compasses to draw perpendicular bisectors of line segments. Margaret has set the exercise in the context of bisecting the sides of a triangle, hoping that some pupils will get as far as finding that the three bisectors cross at a single point (the circumcentre). After a demonstration on the whiteboard, pupils have been asked to draw 'any triangle' in their exercise book, and then draw the perpendicular bisector of each side. While moving around the class, Margaret noticed that several pupils have become confused with their drawings.

Margaret asked the class to stop, and went back to the whiteboard. She wiped off the original drawing of a triangle, and instead drew a single line. She then demonstrated the process of drawing the bisector again before adding a second side of the triangle, and indicating that the process had to be repeated.

In the interview, Margaret described what she thought the pupils had 'got in their heads'.

Int:	What prompted to go back to the board?
Margaret:	A lot of them were leaving it to two arcs and not cutting the line so they were going like that and like that and they thought they had done it. So they had lost sight of what the purpose was which was to cut the line in half. More I think you ought [writing on board] to do two lines, bisect it before you go to the triangle.

Int:	Ok and when you went you went to the board you didn't draw the triangle?
Margaret:	No because if I had drawn the triangle they would have got triangle in their heads instead of bisecting the line in their heads. I wanted to remind them that they were bisecting a line before reminding them that they were doing the triangle. Does it make sense?

Int: So you made a decision to do a very different approach and to focus on that.

Margaret: Yes because they hadn't been drawing the bisector which was ~~ the two arcs. They needed reminding that they were cutting the line in half and then put the triangle in to show that they were trying to do it on all three side because a lot of them were just drawing circles around each corner of the triangle. So this isn't the best lesson I've ever done. (Laughter)

We categorised this episode as *Cognitive problem, Response, Conceptual, Interrogating.* Margaret recognised that some pupils' had become confused by the complexity of their drawings, and were no longer focussing their attention on drawing the perpendicular bisectors. She was able to interrogate their attention and respond by offering a simplified image which re-focussed attention on the individual sides of the triangle, and the process to be carried out.

5 conclusions

On the basis of this small scale study, and the methodology we have developed, we have evidence for the existence of attention-based knowledge as part of what experienced teachers know, both in the sense that they have attentional skills which enable them to 'read' the activity of the classroom, and that they use the knowledge they gain by and from this attention in making judgements about how to act. Further, we argue that the recognition of attention-based knowledge is significant in explaining and justifying why experienced teachers act in the ways they do. On the basis of our study we also conjecture that as teachers develop their experience, their use of attention-based knowledge, and particularly the ability to attend to and interrogate the focus of pupils' attention, will increase.

We are currently planning a more extended study that will allow us to explore this conjecture by using the methodology described here to compare novice and experienced teachers.

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6 appendices

6.i outline proposal for project

Scheme of Research

Research Questions

(1)   Is it possible to detect a role for the concept of intentional coupling in an account of teacher thinking and deliberation in mathematics classes?
(2)   Does the concept of intentional coupling help in identifying the role of judgement in shaping teacher practice, as opposed to practice being shaped by rules?
(3)   Does joint attention (where teacher and pupil(s) share intentional coupling) have a role to play in analysing the management of learning tasks in mathematics classrooms.

Aims and Objectives

Aims:
A   To develop theoretical resources for a general model of embedded expertise.
B   To develop a methodology for detecting the role of intentional coupling in understanding expert teaching practice.
C   To provide guidelines for empirical discrimination between novice and expert teachers in terms of those for whom patterns in teacher behaviour are driven by rules and those for whom patterns emerge from judgement and intentional coupling.

Objectives:
D   To have collected sufficient evidence in response to research questions to frame a full scale research project on embedded expertise in teaching.
E   To have laid the foundations for the development of a generic model of expertise and a general methodology for qualitative empirical research across a number of areas of professional practice.
F   To have provided an initial outline of the character of the expert teacher - 'character' = the assemblage of skills for intentional coupling.

6.ii list of workshops and seminars for project

Workshop 1   July 2003, University of Warwick

Seminar 1   9 January 2004, University of Warwick

Seminar 2   30 April 2004, University of Warwick

Workshop 2   29 June 2004, University of Warwick.

6.iii participants in project

Workshop 1

       Professor Michael Luntley, University of Warwick
       Dr Janet Ainley, University of Warwick
       Mr Ian Jones, University of Warwick (project research assistant)
       Professor Terry McLaughlin, Institute of Education, London
       Dr Jan Derry, Instititue of Education, London
       Professor Nicky James, University of Nottingham Medical School
       Dr Sheila Galloway, CEDAR, University of Warwick
       Professor John Schostak, Univesity of East Anglia

Seminar 1

       Professor Michael Luntley, University of Warwick
       Dr Janet Ainley, University of Warwick
       Mr Ian Jones, University of Warwick (project research assistant)
       Professor Terry McLaughlin, Institute of Education, London
       Dr Jan Derry, Instititue of Education, London
       Professor John Mason, Open University
       Professor Nicky James, University of Nottingham Medical School

Seminar 2

       Professor Michael Luntley, University of Warwick
       Dr Janet Ainley, University of Warwick
       Mr Ian Jones, University of Warwick (project research assistant)
       Professor Terry McLaughlin, Institute of Education, London
       Dr Jan Derry, Instititue of Education, London
       Professor John Mason, Open University
       Professor Nicky James, University of Nottingham Medical School

Workshop 2

       Professor Michael Luntley, University of Warwick
       Dr Janet Ainley, University of Warwick
       Mr Ian Jones, University of Warwick (project research assistant)
       Professor Terry McLaughlin, Institute of Education, London
       Dr Jan Derry, Instititue of Education, London
       Professor John Mason, Open University
       Dr Andrew Davies, University of Durham
       Professor Jan Bransen, Radboud University Nijmegen
       Dr Tim Rowland., University of Cambridge
       Dr Madeleine Wahlberg, University of Warwick
       Dr Martin Gough, University College, London
       Dr Kirsty Wilson, University of Warwick

Footnotes

[1] For example, see Cowan, R (2001) 'Expert systems: aspects of and limitations to the codifiability of knowledge', *Research Policy*, **30**, 1355-1372

[2] J. Dancy, *Practical Reality* ,Oxford: Oxford University Press, 2000.

[3] See, F. Jackson, P Pettit & M Smith, 'Ethical particularism and patterns' in *Moral Particularism* Eds. B. Hooker & M Little, Oxford 2000, pp.79-99 for a clear expression of the point that some patterning must be available to our responses to situations in order for the response to count as one that manifests a sense of reasons for responding.. The Hooker & Little collection provides a good overview to contemporary debates about particularism in ethical theory.

[4] Thanks to Benedict Smith for drawing the Humean facet of Dancy's position to our attention, B. Smith, PhD thesis, University of Warwick, 2004.

[5] See M. Luntley, 'The Character of Learning', *Educational Philosophy & Theory,* special issue on new theories of learning, *forthcoming* for fuller discussion of both the causal and justificatory role of states of insight and discussion of how the theory compares with work on the causal models of performance found in the pyscological literature on adaptive rationality.

[6] The position sketched here is therefore quite distinct from what might superficially seem to be related work on the psychology of human reasonsing, e.g. Gigenrenzer's work on adaptive rationality and his concept of fast and frugal heuristics; cf. G. Gigerenzer *Adaptive Thinking: rationality in the real world*, Oxford: OUP 2000. Gigerenzer's work is open to the objection that it merely identifies the causes of performing well, nifty thinking, rather than that which constitutes performing well. This objection can be found in N. Chater & M. Oaksford, 'The Rational Analysis of Mind and Behaviour' *Synthese* **122**: 93-131, 2000 and also N. Chater, M. Oaskford, R. Nakisa & M. Redington, 'Fast, frugal and rational: How rational norms explain behaviour', *Organizational Behavior and Human Decision Processes* **90**: 63-86, 2003.

[7] The idea of such belief states is due to seminal work by John McDowell 'The sense and reference of a proper name', *Mind* **86**, 1977, 159-85 and Gareth Evans, *The Varieties of Reference* Oxford: OUP, 1982. For a general overview of such work see M. Luntley, *Contemporary Philosophy of Thought*, Oxford: Blackwell, 1999 and for an application of these ideas to epistemology, see B. Brewer, *Perception and Reason*, Oxford: OUP 1999.

[8] Cf Luntley, 'The Character of Learning' op cit, for fuller discussion of this example and of how the theory provides a different conception of 'fit' with the environment to that found in Gigerenzer's work.

[9] The model of teacher expertise is in line with the idea of teachers' craft knowledge as treated in S. Brown & D. McIntyre, *Making Sense of Teaching*, Buckingham: Open University Press, 1993 and P. Cooper & D. McIntyre, *Effective Teaching and learning*, Buckingham: Open University Press, 1996. The model we are proposing provides, however, a much more detailed analysis of craft knowledge, it is also a thoroughly cognitive analysis.

[10] Thanks to Deborah Eyre of the National Academy for Gifted and Talented Youth, hosted at Warwick, for drawing to our attention that the notion of the apprentice expert is often used as a way of thinking of gifted and talented pupils. Thinking of such pupils as experts is held to label usefully the characteristic learning needs of such pupils.