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How efficiently are we using our understanding of the tacit dimension of teaching?

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Abstract

This paper considers the tacit dimension of teaching. Policy and research focused on teaching have addressed the explicit application of knowledge within the field. This paper views knowledge from the positions of explicit knowledge, and implicit or tacit knowledge. Although widely acknowledged as a contributing constituent of teachers' practice, there has been limited research on tacit knowledge in teaching. The nature of teachers' work generates evidence from observable behaviour and action, and has contributed significantly to contemporary research on practice. Where there is a gap in similar expanse of research is on the understanding of the non-observables and implicit or tacit knowledge which informs practice. This area of tacit knowledge in teaching remains minimally understood and under-researched. The research presented in this paper identifies underlying cognitive processes which inform practice in teaching. For the first time in research on teaching, these cognitive processes have been amalgamated to capture what happens beyond that which is observable. A call for unison on the dynamics of implicit and explicit knowledge in teaching is urgent to unearth complexity and externalise professional development stages. The findings from this paper will be beneficial to teachers, teacher educators and policymakers.

KEYWORDS

cognitive processes, decision-making, tacit dimension, teacher thinking, teaching

Context and implications

Rationale for this study

There is a strong body of work on the observable elements of teaching and how observed behaviour contributes to an improved understanding of practice. There is limited insight of the tacit composition of teaching.

Why the new findings matter

Research into teaching acknowledges the place of tacit knowledge which underpins teacher action. This paper contributes to the field in the identification of cognitive processes which interact and subsequently activate observable teacher action or behaviour. Teacher thinking, evidenced in cognitive processes precedes teacher action and behaviour. Decision making in teaching is foundational, and the interplay of seven cognitive processes which this paper explores, advances understanding of the tacit composition of teaching.

Implications for practice

This paper impacts on the field of teaching in its ability to externalise the cognitive processes which shape practice. Whilst there is significant provision for the explicit knowledge of practice, there is limited understanding of the implicit constituents of teaching. From this paper, teachers are equipped with the understanding needed to develop the tacit elements of their practice. Another implication is on teacher education in the delivery of an enhanced and holistic preparation of new entrants to the profession. For policymakers, relevant policies which support teachers' development could be informed by knowledge of the tacit composition of teaching.

INTRODUCTION

In a study on teacher cognition Enow (2016) concentrated on the pre-active phase of teaching, emphasising the high proportion of teacher's time dedicated to instructional preparation, for example lesson design or lesson planning. Based on an extensive literature review which was undertaken as part of doctoral research, the following recurrent cognitive processes were isolated from the body of existing literature on teaching, and more generically on education: (1) decision-making, (2) problem solving, (3) reasoning, (4) judgement, (5) memory, (6) perception and (7) intuition. The centrality of the study is on how the mind of the teacher works when undertaking a primary function of teaching; that of planning. The mind is complex, and it could be argued this complexity contributes to the ongoing and pertinent discussion on the inherent complexity of teaching (see Sinnema et al., 2016; Strom, 2015; Strom & Viesca, 2021). Teacher education identifies this complexity as exemplified in disconnect between pre-service teacher learning and learning implementation in classroom practice. Connectivity gaps persist in professional development and whether or not desired change in practice (McChesney & Aldridge, 2021) is effected, and the tacit composition of teaching appears in a zone outside the periphery of policy makers. This paper therefore aims to externalise cognitive processes in teaching captured through verbalising of thought processes during instructional design or lesson planning. The five-stage Dreyfus model (Dreyfus & Dreyfus, 1986) of skill acquisition is the conceptual framework for this work and has been

used to underpin the analysis of levels of expertise of the teachers who are participants in this research.

The research in this paper has drawn on cognitive psychology and its insights on cognitive processes. Over time, depending on the area of focus, teaching has been influenced by different fields. It seems behavioural psychology and developmental psychology continue to dominate studies seeking to understand learning and teaching. However, contemporary influential work, for instance Hattie and Yates (2013), has turned to cognitive psychology; signalling a way forward in research on learning and teaching with a shift from observable behaviour to non-observable cognition. Although Hattie and Yates (2013) focus on learning, this paper takes an exclusive focus on teachers and teaching. Current debates emanating from the social constructivist theoretical influence examine cognition from a social lens arguing that cognition can be externalised. Hutner and Markman (2016) challenge the introspection characteristic of cognitive processes and introduce group cognition.

Individual cognition is central to the present research. The methods of data collection utilised in Enow (2016) actively target ways in which thought processes could be externalised by each research participant. This is congruent, in a sense, with Hutner and Markman (2016) on the issue of whether cognitive processes are exclusively introspective. Similarly, this argument reflects contemporary research on teacher expertise (Goodwyn, 2011, 2017a), which seeks to capture, study and externalise expert performance. The relevance of expertise in this paper is in the knowledge that teachers are at various stages in their teaching expertise development. In light of this trend to interrogate that which evidences teaching skill and classroom interaction beyond observables such as lesson observation, research on cognitive processes becomes imperative in comprehending the highly nuanced and complex constitution of practice. Berliner (1987:84) states categorically that 'teacher behaviour is substantially influenced and even determined by teacher thought processes'. Research on teacher behaviour (Korthagen, 2017; Maulana et al., 2015), teacher beliefs (Biesta et al., 2015; Fang, 1996; Kagan, 1992), and teacher knowledge (Adoniou, 2015; Dickerson et al., 2022; Li & Sang, 2023) are extensive across the field. Teacher behaviour is explicit, can be seen, observed, evaluated and understood. Research on teacher beliefs has significantly contributed to teacher education. Teacher knowledge has established avenues in teacher education and work-based learning settings. An amalgamation of the depth and breadth of research on teacher behaviour, beliefs and knowledge continues to impact on the field. Corresponding research on the tacit composition of teaching is lacking in comparison. Li and Sang (2023) in their work on teacher beliefs highlight the emerging shift in focus towards tacit knowledge.

THE IMPORTANCE OF COGNITIVE PROCESSES IN TEACHING

Transformation of curricula knowledge into quality provision for learners is distinctive to the work of teachers. Maclellan (2012) draws on Shulman (1986) with the generation of Pedagogical Content Knowledge (PCK) as the key distinguisher of knowledge exclusive to teachers within the profession. While tracing Shulman's influence to Maclellan (2012) emphasises that research on cognitive processes of teachers is entangled with the cognitive processing of the learners. The argument inferred in this critique emanates from the need to fully understand each of these in more depth before establishing any connections. Maclellan (2012) also bemoans the loss to teacher quality created by 'misplaced' emphasis on pedagogical knowledge in research with minimal corresponding focus on the cognitive composition of teaching. Coleman (2014:1) states emphatically that 'by ignoring or overlooking the teacher's thoughts we omit a rich body of information about professional practice…'.

This paper therefore seeks to explore this 'missing' knowledge and to deliberate access to this area of teachers' minds and thinking, hence contributing to filling this pertinent gap in research on teaching. Although this paper uses data from English teachers, the cognitive positioning, it could be argued, enables the insights and findings of this empirical work to be applicable beyond school subject confines.

RESEARCH DESIGN

Researching into the mind or teacher cognition research lends itself to methodologies and methods attuned to retrieving and engaging with non-observable data. This research aligns with the qualitative tradition and welcomes the subjective thoughts of the participants. The mind of the participants is the target in this research, specifically thought processes. Participants have been drawn from secondary schools in the midlands (England), all of whom are English teachers. This choice of secondary teachers is intentional and supported by suggestions of difference in some of the cognitive processes between primary and secondary teachers (see Sheridan et al., 2019). Seven data collection methods were used (see Enow, 2016) with the inclusion of think aloud (Eccles & Arsal, 2017) and stimulated recall (Lyle, 2003), as these are typically utilised by researchers of cognitive processes to facilitate access to thought processes. Barton (2015) groups these methods together with the term 'elicitation techniques' and the explanation that they accentuate thought processes that otherwise would not be verbalised. Combining think aloud and stimulated recall in this research involved participants verbalising their thinking as they completed a lesson design activity, and this was subsequently followed with a stimulated recall opportunity, which accessed another layer of thinking from the think aloud. The rationale for this combination is a result of the transient nature of thinking, which needed to be relatively stabilised in order to be captured. It could, however, be argued that it is not necessary to stabilise the data but consideration was given to critiques of qualitative research around rigour and credibility. In particular, critique on the rigour and systematic application of think aloud protocol and verbal reports in qualitative research continues to be challenged (see Leighton, 2021).

THE COGNITIVE PROCESSES IN TEACHING

Within literature on cognitive processes (e.g., Kahneman, 2003), irrespective of the discipline, recurrent areas constituting cognitive processes are: (1) decision-making, (2) problem solving, (3) reasoning, (4) judgement, (5) memory, (6) perception and (7) intuition. As already specified, within teaching there is substantial research on decision making. In fact decision making, one of the seven cognitive processes, is generally agreed to be an influential determinant in the work of teachers. This agreement amongst teachers and within the teaching profession, emboldens the resolve for this paper to make the case, and very strongly too, that teaching research should take a cognitive turn. Because the profession already acknowledges that decision-making is central to teaching, this is the point where researchers, professionals and practitioners interrogate and bring into the fold the other identified cognitive processes. There is a lot to be gained in understanding teaching with the interrogation, investigation and exploration of the cognitive realm. It must be clarified, though, that some of these identified cognitive processes are actively used and understood by teachers, for example (professional) judgement, (pedagogical) reasoning, and problem solving. However, these appear to be prominent either in isolation, or in specific subject areas. Enow (2016) takes a more holistic view to cognitive processes; engaging with the interplay of these cognitive processes, as well as identifying a hierarchy of cognitive processes.

DECISION-MAKING

Decision-making dominates research on teacher cognition. When researchers into teaching isolate and study cognition, there is a tendency for decision-making (see Eley, 2006) to be their main focus. This is, of course, highly welcome as an introduction to teacher cognition. To go beyond this dominant singularity, and embrace the multiplicity of cognitive processes is the next step. Teachers' decisions are evidenced in their action and pedagogical content knowledge interaction. As stated in this paper, there are also available elicitation methods which should be taken up by researchers and practitioners. Added to this, professional development creates space to verbalise teachers' instructional design thinking; however, knowledge of the different cognitive processes enables shared understanding of these verbalised thoughts. In essence, group cognitions identified by Hutner and Markman (2016) become viable only with enhanced knowledge of individual cognition. Lysberg and Rusk (2022) identify gaps in research on the decision-making processes of teachers working in collaborative spaces during professional development, noting that very little is known about the impact of such collaboration.

There is rich knowledge to be gained from understanding the cognitive composition of teaching. Decision-making is activated when a teacher thinks about their lesson, irrespective of whether or not they have a written lesson plan document (see Enow & Goodwyn, 2018). Although teacher cognition research captures dominance of decision-making, interplay of cognitive processes, in particular decision-making, does not happen in isolation of the other cognitive processes. Enow (2016) found that while some teachers go from perceptions straight into decisions (e.g., novices) others access a combination of cognitive processes, and some the full range inclusive of some of the subsets of each of the cognitive processes (e.g., memory; long-term memory, short-term memory, recall, etc.) before arriving at a decision. The data shows teachers exhibit interplay of cognitive processes; and teacher quality can be enhanced with better understanding of these non-observable constituents. The differentia with decision-making is the speed at which to arrive at the decision in a way that does not visibly affect ongoing action, but is used to steer the learning ‘effortlessly’.

PROBLEM SOLVING

It is rare to find work which addresses teachers' cognitions during problem solving in cognitive processes research, and this unveils an empirical gap. Problem solving appears to be ‘relegated’ to studies in specific subject areas (for example, Depaepe et al., 2010). Popp (2021) highlights instructional problem solving through reflection, specifying the dynamic ways in which teachers work through their problems of practice for the purpose of enacting change. From the empirical work by Enow (2016) there is confirmation that English teachers engage in problem solving when they are at the pre-active phase of teaching. When the focus has been the learners, there is a reasonable amount of work on problem solving. In fact, in some circumstances teachers are expected to grade the problem-solving ability of the learners. This makes it even more imperative for teachers to be aware of their own problem-solving aptitude, in particular to facilitate implementation during pre-active instructional design and interactive classroom engagement.

It is empowering to have the ability to ‘break down’ and note the individual constituents of these cognitive processes which externalise the mind of the teacher at work. The agency of the teacher is enhanced when they have this knowledge of themselves to hand, to use in the post-active reflection phase. Mena Marcos et al. (2008:109) for instance, do not use problem solving but recommend its use in understanding teacher reflection. In the triumvariate of pre-active, interactive and post-active phases of teaching, reflection is situated in the

post-active phase; one of, not the sole, activity of this phase. Linkage between cognitive processes and the three phases of teaching is therefore established. Enow (2016) identifies this evidence of problem solving as it is handled by a teacher at the Dreyfus and Dreyfus (1986) competence stage of expertise development:

> what I'd planned was they would annotate the quotes and then they would provide the analysis but because it was the first time we'd done it, they were very uncertain in their analysis on quotes. So, when we were actually doing the feedback, rather than letting them take the lead, I took lead and then I asked, trying to facilitate their group to just jump in with a few points.

This example introduces the identification of problem solving and highlights some challenges that teachers at the competence stage still grapple with; in this case, control and the inability to let go in terms of direction of travel of the lesson. There is a tendency for competence stage teachers to be inward-facing and teaching-focused, whereas expert level teachers are outward-facing and learning-focused. The problem-solving excerpt of the expert teacher highlights this:

> That was their interest rather than the narrative structure. Therefore I decided to follow their lead there because inevitably I talk about the narrator, we would also be talking about the narrative structure but not quite in the way I had intended. Another factor which influenced my change of direction, was that it wasn't just an interest in the narrator, it was a well-informed interest in the narrator in that they were starting to refer outwards to previous knowledge on the Gothic. Now the Gothic would have come into the next lesson as part of our examination of the first part of the Rime of the Ancient Mariner as oppose to the ballad features. So in a in a sense they were just moving to the next lesson and its its direction so I just took that opportunity as they were engaged in that area. So we started to discuss the nature of the narrator, using their, well two things; using their knowledge of Gothic Literature and strange bizarre narrators and also were building upon that more speculatively on the the identity of the narrator. Now, again this one was material really for future lessons but I decided to strike while the iron was hot.

REASONING

'Pedagogical reasoning' is a key concept in teaching that was introduced by Lee Shulman (1987). In theorising about the knowledge bases of teaching, Shulman explicates the difference between content knowledge and pedagogical knowledge, emphasising the importance of reasoning in teachers' decision-making. Fenstermacher (1994) is another example of research on reasoning and its historical position on research into teaching. Maclellan (2012:414) also pinpoints and utilises the terminology 'pedagogical reasoning'. Contemporary research (Loughran, 2019) affirms the place of pedagogical reasoning in this exploration of cognitive processes, with Ovenden-Hope and la Velle (2015) signposting links between strength in pedagogical content knowledge and pedagogical reasoning.

As already pointed out in this paper, using the cognitive processes as a collective, rather than in isolation typical of current usage, has immense benefits for teaching and research on teaching. The case for a holistic positioning of cognitive processes emerges gradually. In Gholami (2011) reasoning behind decisions are examined. In tandem with Gholami (2011), Loughran (2019) establishes strong connections between pedagogical reasoning and

decision making. From the research (Enow, 2016), some results on reasoning are presented and organised from the position of teacher expertise. It is helpful to see from the results that expert, competent and novice teachers all engage in reasoning during the pre-active phase of teaching. So, what is the difference, or indeed is there a difference? Primarily, the quality of the reasoning is different. Experts are able to externalise reasoning almost spontaneously, at times even before prompting, as evidenced during the period of data collection using think aloud and simulated recall research methods:

> …if you've got off to a good start, an engaging start, then the lesson would go smoothly and the children will engage a lot more quickly as opposed to the rather perhaps dry steady start in which perhaps the students have disengaged by 30 to 40 seconds into a into the lesson. Given the culture that they come from of er instant gratification and sound bites, you really have to, in my mind, engage them within the first 10, 20 seconds of the em lesson.

Although this excerpt is a snapshot, the expert spends an 'intense' amount of time during the pre-active phase refining reasoning, which subsequently supports the interactive phase of teaching. In contrast, non-experts rationalise rather than being comprehensive in their reasoning. Understandably, for novices reasoning tends to be superficial. Sheridan et al. (2019), however, advocates for careful consideration of teacher beliefs and motivation with regard to their impact on teacher reasoning for pre-service teachers. Another differentia is the nature of the reasoning. Experts, generally, are outward-facing. In presenting their reasoning, experts show evidence of a learner-centred approach. For the expert, the whole teaching process actively revolves around the learners and their learning. This means reasoning by the expert is tuned in with the knowledge-processing ability of their learners, knowledge of which experts have quite advanced understanding. In sum, expert reasoning surrounds how to expertly manage the learning.

A divergent outlook between expert and non-expert teachers is embedded in their engagement with reasoning. Non-expert reasoning showed the tendency to be inward-facing, typically focusing on the teaching and the procedural element. Experts are outward-facing with a focus on the learner and their learning. It could therefore be said that non-experts engage in reasoning using a teacher-centred approach. The non-expert appears to take responsibility for the teaching whereas the expert targets the learning explicitly. Pedagogical reasoning, therefore, impacts on instructional design with visible impact on both learning and teaching.

JUDGEMENT

Doddington (2013), following on from the seminal work of Tripp (1993), reiterates the term 'professional judgement'. This terminology is not new, neither is it exclusive to teaching. Phronesis—the practical wisdom of teachers which informs their judgement, as is sometimes referred to—is a philosophical Aristotelian term. Various terms are associated with judgement in teaching. Horn and Campbell (2015:155) use pedagogical judgement, with the explanation 'Pedagogical judgment is at the very heart of ambitious teaching practices. By design, these practices aim to be responsive to particularities of students and situations.' Although there is substantial literature on teachers' professional judgement, there is minimal empirical work on judgement as one of the key cognitive processes that determines teacher cognition. Hence, the contribution in this paper.

Enow (2016) found that experts dedicated more time to making informed professional judgements. Expert judgements are based on data elements, deep knowledge or 'knowing'

of students, inclusive of affective attributes as highlighted by Hattie and Yates (2013). In Enow (2016), experts were found to make judgements in the pre-active phase, which enabled them to create 'sub-plans' leading to them preparing for alternative trajectories of the lesson during the interactive phase. This, in essence, showcases the cyclical nature of the teaching process as well as the link between professional judgement and decision making. What begins to emerge is the extensive non-visible work that happens in the teacher's mind. The complexity in teaching (see Adoniou, 2015) begins to emerge and even translates as the complexity of teachers' cognition. For example, Lysberg and Rusk (2022) specify that decision-making by teachers is complex. To put this into context, decision-making is only one of seven cognitive processes addressed in this paper. Unveiling the cognitive realm provides a window into the work of the teacher, which hitherto has been narrowed down to mainly the observables.

Before teaching is expressed in its observable form, an incredible amount of work has already taken place. It is of course commonly known within the field that teaching is complex; multilayered, multifaceted, contextual and dynamic. It is important to return to the already stated point that this knowledge provides teachers with agency, which understandably is a key ingredient for teacher autonomy. As an extension of the way in which professional judgement features in teaching, and any insights it might provide, Enow (2016) found non-experts, based on their planning externalisations, expected to go into the interactive phase in order to make and use professional judgements on their learners. This use of professional judgement, which is located in the interactive phase rather than the pre-active phase, could present some obstacles, for example time and pace decision-making challenges, for the non-expert. Some non-experts are already saddled with cognitive overload; adding high levels of cognitive processing and decision-making in the limited frame of interactive teaching might not be suitable action. It was found that during lesson planning, non-experts expect to check prior knowledge during the lesson, heavily reliant on using the Question and Answer strategy (Q and A). The usefulness of Q and A as a teaching strategy must not be undermined. However, the question is how much of the 'knowing' of the learners does the teacher already have, and how is Q and A then used? There is a significant difference when Q and A is used as a confirmatory instrument for what the teacher already knows of the learners, and when Q and A is used as an investigative instrument to find out *in situ* what the learners know—which then necessitates an impromptu change of lesson trajectory. In the hands of an expert, there is evidence that professional judgement takes place in the pre-active phase, necessitating sub-plans with multiple trajectories should the situation arise.

MEMORY

Returning to the interdependence of cognitive processes, it is important to draw on Maclellan (2012), which dedicates a section of the paper to cognitive processing and memory. This corroborates the Enow (2016) thesis finding on memory not only as one of the cognitive processes but, as Enow (2016) specifies, a key determinant in growth in teacher quality and attaining target levels of expertise development. This confirmation of memory as one of the core cognitive processes both consolidates its place in teaching and teacher cognition and also brings education research one step towards parity with cognition research in other fields. Memory is an interesting one in teaching research and teachers' discourse. It is widely accepted in teaching that memory is pivotal to learning. Considering that teaching itself begins with a typically heavily didactic positioning in the form of teacher education and or school-based teacher training, existing literature appears to escape capture of how memory shapes the learning and, indeed, life-long learning of

teachers; except in the rather selective discussion of cognitive load (see Feldon, 2007; Nathan & Petrosino, 2003) of new entrants to the profession at the novice stage of teacher expertise development. Why there is this selective and isolated handling of memory is incomprehensible. If we consider that professional growth (see Goodwyn, 2017b) for the English teacher depends heavily on memory, and in fact any development of expertise relies on memory as its strongest variable (see Ericsson et al., 2013; Ericsson & Pool, 2016), there is an urgency to research and use memory in the domain of teaching in more ways than are currently being used.

> Memory is evident in how the experts access what they know of the students to be able to make decisions, reason, and judge when they are planning. When the competent level teacher (Eric) accesses memory it is to find something they have used before, for example resources, or how a lesson they have previously taught flowed (that is, the structure elements or lesson procedures used), in order to make minor amendments. (Enow, 2016)

PERCEPTION

Studies on teacher effectiveness have tended to access students' perceptions as well as teachers' perceptions. Research conducted by Phillips et al. (2021) presents insights relating to years of experience and both student and teacher perceptions of effectiveness. From the research there is minimal agreement in perceptions between the students and teachers about teachers with experience of 5 years or less. For teacher experience of between 6 and 10 years, there is stronger alignment of both teachers' perceptions of their effectiveness and students' perceptions of teacher effectiveness. It is noteworthy that this alignment becomes weaker after the 10-year experience point. This weaker alignment appears to link with expertise research assertion that years of experience does not equate to expertise. Using the Dreyfus model as applied by Enow (2016), the less than 5 years' experience falls generally in the non-expert stage of expertise development. Existing research on teaching exemplifies teacher perception, for instance Le Fevre (2014) and Schempp and Johnson (2006). In the application of teacher perception to observed student behaviour relating to signals indicating that students understand the content they are learning, Vagle (2009) combines perception with reflection. A relationship can therefore be assumed between perception, reflection and teacher expertise, with the position that teacher perception engagement and articulation appears linked to stage of teacher expertise development. An example is teacher perception at the novice stage as captured by Enow (2016) in this excerpt:

> Also, I just, one thing I've noticed is when it comes to things like grammar and sentences the older you get the more you tend to forget, from what I understand.

With basic teaching experience and reliance on the experiences of others, the novice teacher at this stage in their development might not yet have enough evidence to make a generalisation such as this, hence relying on their perceptions. These perceptions left unchallenged could impact on the students. The learned ability to externalise and engage with individual perceptions such as this one will make the difference that this paper advocates. In this example from a pre-service teacher, knowledge of cognitive processes could be used effectively in teacher education to enable pre-service teachers to engage with their pedagogic cognitions. Teaching is complex (see Sinnema et al., 2016; Strom, 2015) and unique because teachers work with learners who bring knowledge, a range of qualities, and experiences to each individual learning opportunity. The complexity of teaching is thus experienced in the dynamic, non-static nature

of the interactive phase of teaching. Innovative practice in teacher education and training is essential in nurturing access to pre-service teachers' cognitive processes, which are currently minimally captured in lesson observations and reflections.

INTUITION

According to Ericsson (2013:686) intuition is essential in actions taken by experts in challenging situations. Experts have to purposefully draw on their intuition in these situations in order to achieve 'superior' outcomes. Very often expertise is explicit because in some instances such situations have never been experienced before by the expert. Non-experts tend to rely on prior experience to achieve an outcome. Harteis and Gruber (2006) confirm there is a knowledge base for intuition. It could be said, unlike perception, intuition in teaching comes from a position of knowing. This knowledge in the hands of the expert faced with a relatively never-before-experienced challenge is constructed with a suitable amount of fluidity and speed, exhibiting automaticity. Betsch and Glöckner (2010) argues that intuition is capable of dealing with complex tasks through extensive information processing without noticeable effort. The intuitive decision-making capability of the expert teacher also means precise and timely use of pre-empting and intervening; showing superior performance in solving a problem even before it occurs. Despite the significance of intuition in the superior performance of expert teachers, as Hattie and Yates (2013) notes, there are still very few studies on teacher intuition.

IS THERE A HIERARCHY OF COGNITIVE PROCESSES?

Figure 1 provides a visual representation of the cognitive processes during a teacher's pre-active phase of instructional design. This diagram shows that more than one of the cognitive processes is at play at any given time. With the partly shaded arrows presenting the interactions of non-expert teachers and the fully shaded arrows representing the interactions of the experts, there is confirmation that teachers at all stages of expertise development engage with combinations of cognitive processes beyond the dominance of decision making. In effect, decision-making appears to locate itself as the final step, that is, just before action is taken. The currency of decision-making as the final step before action is taken could explain why it is the most prominent cognitive process linked to teaching. Clearly, as Figure 1 shows, the mind of the teacher has engaged with other cognitive processes before arriving at decision making. This is pertinent insight especially considering that both experts and non-experts make multiple engagements with the cognitive processes. Agreed, there are differences in the extent to which each teacher, depending on their stage of expertise, will engage with the cognitive processes—the unifying element is the interplay of these cognitive processes. The expert goes through all of the cognitive processes before arriving at decision making. It is important to highlight, based on expertise research, that the nature of this interplay in the hands of the expert is that of automaticity. By externalising these cognitive processes, Enow (2016) adheres to calls for researchers on teaching to unearth the complexity of teaching and also calls for expert level teachers to make their expertise available in order to be studied and understood. Figure 1 therefore opens up the working of the minds of teachers at different stages of expertise development in order for teachers to 'see' what is required for their professional growth. As well as being empowered with the agentic aptitude to locate their stage of expertise development, teachers also gain access to the hitherto non-observables.

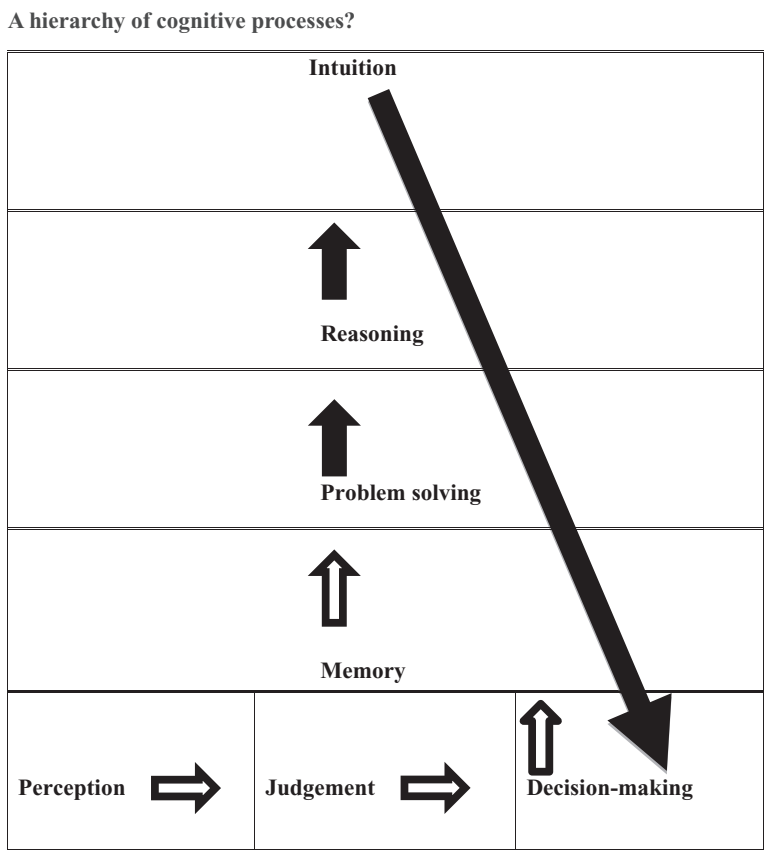

FIGURE 1 Hierarchy of cognitive processes (Enow, 2016).

Is there really a hierarchy of cognitive processes? Intuition is the peak of Figure 1 and this is based on findings from expertise research. Although teaching has not actively engaged with the cognitive processes in a manner that is holistic, as this paper has now done, the only available option has been to look into empirical expertise research in other fields. Many theoretical models have been explored with few of such models actually making it to empirical work; the first (Enow, 2016) of which has been the Dreyfus model in teaching. The choice of the Dreyfus model has been informed by research in nursing, for example by Patricia Benner (Benner, 2001, 2004), a profession typically categorised alongside teaching.

The discussion on hierarchy of cognitive processes reveals that experts think in non-linear ways. Dreyfus and Dreyfus (1986, 2005) describes experts as arational. Experts showcase a complex interplay of cognitive processes, resulting in lessons that capture the essence of quality in teaching. For each lesson focus, an expert has a bank of lesson permutations and is able to activate thought processes consisting of problem solving, decision making, reasoning, judgement, memory, perception, intuition, in a manner which from observation of action, seems effortless. The difficulty with observation of the action of an expert teacher is in the perception of the observer that teaching is easy. The tragedy of this perception is, I believe, its impact on the attrition rate of novice stage teachers who are unable to replicate that which they have just observed. The societal impact of this perceived nature of teaching could also contribute towards explaining contemporary societal attitudes towards teachers and teaching, at least in our case of the UK.

Ericsson et al. (2013:694) and Ericsson and Pool (2016) both place great emphasis on expertise as an 'effortful' process; with deliberate practice at its core. Sinnema, Meyer and Aitken (2016:7) summarise—teaching is complex because there are many unknowns and uncertainties incorporating multiple dimensions and many different processes which make it challenging for teaching to be routinised. It is fitting to end this section with the assertion by Ericsson and Pool (2016:146) that 'deliberate practice is for everyone who dreams … it's for all those who want to take control of their lives and create their own potential and not buy in to the idea that this right here, right now, is as good as it gets'.

CONCLUSION

This paper externalises cognitive processes in teaching, identifying decision-making, problem solving, memory, reasoning, judgement, perception and intuition. These are interwoven and the various combinations reflect the stage of expertise development of the teacher. This paper also highlights the hierarchical structure of these cognitive processes with the location of intuition at the peak. A key insight from this paper is the role of non-observable, implicit constituents of teaching. Another crucial point is drawing attention to effective usage of this knowledge of the tacit elements of teaching. A gap in research remains between the explicit and the implicit components of the work that teachers do. Further research could examine application of cognitive processes in other subjects areas and across phases of education.

The tacit dimension of teaching ultimately requires more attention from researchers, practitioners and policy makers. Loughran (2013), in addressing the knowledge bases of teaching, emphasises the strategic importance of tacit knowledge. Again, here lies the challenge—the tacit nature of this kind of knowledge about teaching generates challenges with retrieving this knowledge in order to study it and understand it. Tacit knowledge, whilst not exclusive to teaching, is recognised across fields for its importance in enabling users to complete required tasks but is also vital in developing practice. There is debate in domains with more advanced understanding of tacit knowledge in relation to its ownership; that is, whether it belongs to an individual or whether it is collective ownership (see Calderhead, 1987; Lejeune, 2011; Loughran, 2013; Nonako & von Krogh, 2009; Toom, 2012).

Teaching stands to benefit immensely from taking a cognitive turn as already specified in the introduction to this paper. The benefits begin with activating the agency of the individual teacher to self-locate on the five-stage Dreyfus model, activate self evaluation of understanding of cognitive processes, engage with the demands of their developmental stage, take on the responsibility of professional learning and make the choice of professional growth in a personalised and self-directed manner. Policy makers are also now informed of the areas for investments in teaching that are rewarding for teachers and their teaching, with the resultant effect of producing quality teaching. Teacher education and teacher training, informed by this paper, do now have a clear trajectory that is realistic in guiding new entrants to the profession through teaching from the lens of a lifelong career and profession.

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There is no conflict of interest.

DATA AVAILABILITY STATEMENT
Research data are not shared.

ETHICS STATEMENT

University ethics approval was gained for the research which underlines the content of this paper.

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