

A Critical Analysis of the Relationship Between Teacher Subject Knowledge and Effective Learning and Teaching in the Primary School

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Introduction

Cognitive research suggests that teachers must be equally concerned with *how* they teach as *what* they teach, if pupils are to succeed (Bruer, 1993). This implies that teachers require knowledge of content and learning strategies which engage pupils. In his seminal work, Shulman identifies a “knowledge base for teaching” – ‘a codified or codifiable aggregation of knowledge, skill, understanding and technology, of ethics and disposition, of collective responsibility’ (1987: 4) – suggesting that different types of knowledge impact upon teachers’ practice. Following Shulman, many pedagogues consider different types of knowledge as important for effective teaching and learning and I analyse such disparities within the literature below.

Brookfield (2002) suggests teachers may reflect upon their practice through four lenses: personal experiences, learners’ perspectives, colleagues’ experiences and critical literature. An informed reflection relies on multiple observational methods (Foster, 1996), whilst sound reasoning about one’s teaching requires both reflective thinking and an adequate base of theoretical understanding (Fenstermacher, 1978). Consequently, after reviewing the critical literature, I also reflect upon my Professional Teaching Experience (PTE) to analyse, evaluate and propose measures for developing my knowledge and teaching practice. However, self-evaluation has limited validity in determining teacher effectiveness (Coe *et al.*, 2014), therefore I cite formative observations of my classroom practice and evidence of pupil attainment to substantiate evaluations of my knowledge base.

Within this assignment, I make ethical considerations in my discussion of my PTE school, its pupils and staff. All references to the aforementioned are anonymised and treated in adherence to BERA guidelines (2018); the school has consented to this.

Literature Review

Teachers' pre-training experiences strongly influence their subject-specific content knowledge (CK)¹, and consequently inform their teaching practice (Feimann-Nemser, 1983). Kleickmann *et al.* (2013) support this by suggesting that mathematics graduates commence teacher training with greater mathematics CK than other trainees; this difference escalates during their teaching careers, suggesting graduates are more receptive to accruing new CK within their field (see *Fig. A.*). As a Literature graduate, then, I perhaps have advanced CK in this curriculum area, yet the highest mathematics qualification I hold is a GCSE. Thus, even if I develop my mathematical CK, the trend shown by Kleickmann *et al.*'s (2013) study of secondary school teachers suggests that the 'expert' in the field always holds greater knowledge and would, therefore, be better equipped to teach their specialism. Donaldson concurs that 'subject expertise' is essential for good teaching (2015: 63), yet it is an unachievable aspiration for primary teachers to possess expert CK in all curriculum areas. This suggests that Kleickmann *et al.*'s findings may not be successfully extrapolated to the primary context.

¹ The term 'content knowledge' (CK) refers to the knowledge teachers hold about the specific topic they are teaching. In the literature discussed this may also be referred to as Content Knowledge for Teaching (CKT) or Subject-Matter Knowledge (SMK) but in this assignment the term 'CK' will be adopted in lieu of these other terms for purposes of consistency and clarity.

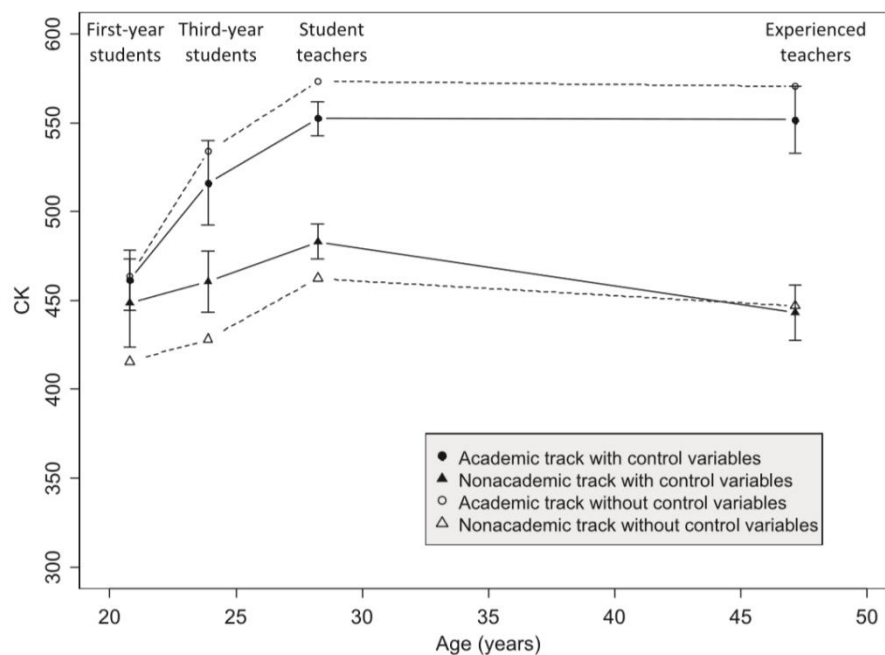


Fig. A. A graph comparing pre- and in-service mathematics teachers' CK as assessed by standardised tests (Kleickmann *et al.*, 2013: 98).

In contrast, Barnes stresses that it is unreasonable to regard 'completion of an aggregate of courses as sufficient evidence of teacher understanding' (1989: 13). Likewise, Ma (2010) claims that effective teachers only require deep mathematics CK *at the level they are teaching*; Rowland *et al.* argue that 'it may not be important to understand advanced mathematics to teach primary mathematics effectively' (2009: 23); and the latest research from Hong Kong finds 'pedagogic efficacy to be more strongly associated with pupil achievement' than secure CK, despite 'international calls for the enhancement of primary teacher's mathematics CK' (Fung *et al.*, 2017: 119).

McDiarmid *et al.* (1989) assert that good teachers understand their content and how to effectively instruct pupils in it, supporting Shulman's (1987) hypothesis that strong CK amongst teachers alone does not initiate effective teaching and learning. Instead, 'content knowledge and pedagogical strategies necessarily

interact in the minds of teachers' (Shulman, 1987: 5) and become 'pedagogical content knowledge' (PCK). For Shulman (1987), PCK combines CK, pedagogical knowledge and knowledge of the pupils being taught, suggesting that a teacher's expertise does not guarantee pupils' progress in a topic. To facilitate this, teachers must adapt their delivery of content in accordance with their knowledge of pedagogy and their pupils. This could be challenging for student teachers who may not initially comprehend pupils' prior knowledge and learning needs fully enough to undertake accessible and inclusive teaching. PCK may, therefore, be a weak facet of the knowledge base for many beginning teachers.

Shulman uses qualitative case studies of teaching episodes to substantiate his conjecture that PCK is essential for effective teaching, yet quantitative findings appear to support this. Kleickmann *et al.* (2013) assessed PCK according to teachers' written responses to hypothetical classroom situations. Their findings suggest that PCK develops as teachers gain experience and imply that 'academic candidates' with a degree in their teaching subject may develop PCK at a faster rate than 'non-academic candidates', especially after they become qualified teachers (see *Fig.B.*). Consequently, Kleickmann *et al.* conclude that 'higher CK may lead to increased uptake of learning opportunities to acquire PCK' (2013: 100), suggesting that PCK may be underpinned by strong CK.

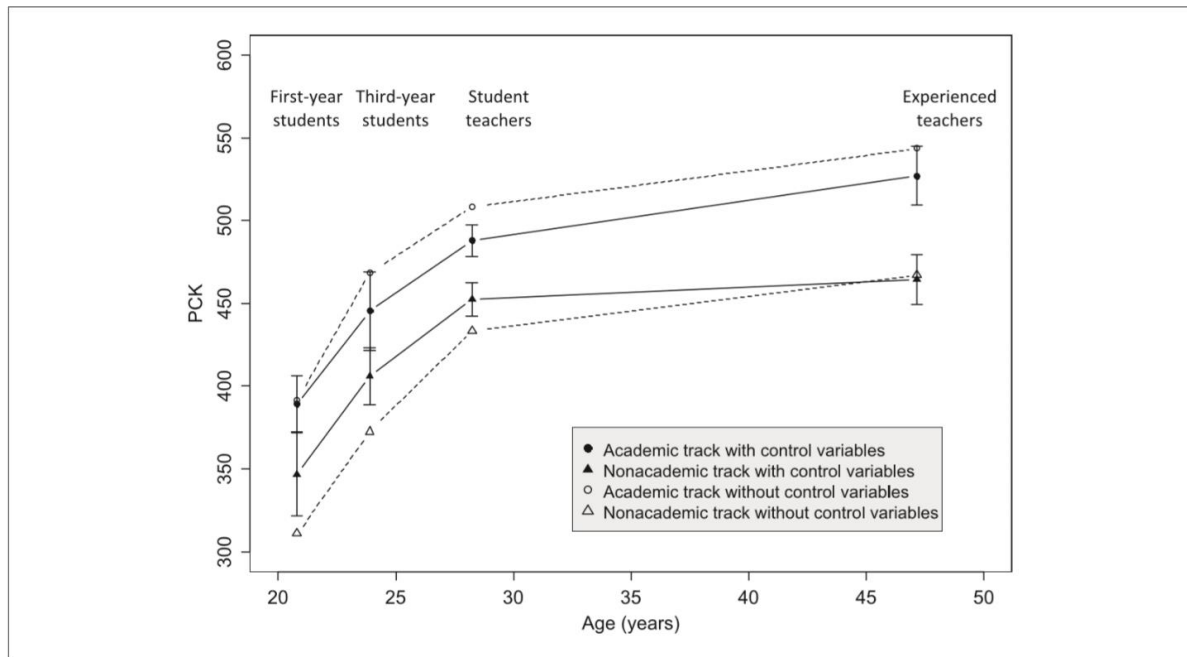


Fig. B. A graph comparing pre- and in-service mathematics teachers' PCK as assessed by standardised tests (Kleickmann et al., 2013: 98).

The knowledge base for teaching is growing (Shulman, 1987) - a poignant observation for Welsh education which is on the precipice of a new curriculum; teachers in Wales will be required to modify their existing knowledge to incorporate the new curriculum structure. Coinciding with Shulman, Donaldson (2015) considers subject knowledge for teachers to be more than pedagogy or CK. In his recommendations for the Welsh curriculum, Donaldson suggests that pedagogical knowledge 'represents the considered selection of [teaching] methods in light of the purposes of the curriculum and the needs and the developmental stage of the children' (2015: 63). This reflects Shulman's emphasis on knowledge of learners and highlights Shulman's identification of 'curriculum knowledge, with particular grasp of the materials and programs that serve as "tools of the trade" for teachers' (1987: 8). These tools are about to change in Wales, with a shift from discrete subjects to six "Areas of Learning and Experience" (**Expressive Arts; Health and Wellbeing; Humanities; Languages,**

Literacy and Communication; Mathematics and Numeracy; Science and Technology) (Donaldson, 2015: 39), and teachers' knowledge will have to evolve accordingly.

Shulman studies American secondary teachers but considers whether his hypotheses are generalisable to primary education: 'the centrality of content knowledge in pedagogy holds reasonably well for the elementary level as well, [but] I am reluctant to make that claim too boldly' (1987: 19). Shulman's work was developed by Rowland *et al.* (2003) in their formulation of "The Knowledge Quartet" which considers the knowledge base from the primary aspect citing research undertaken in British schools. It concerns only mathematics teaching, although the framework may be pertinent for other curriculum areas. The constraints of this assignment prevent detailed elucidation and synthesis of these works, therefore a summarised appraisal is provided in *Fig. C*.

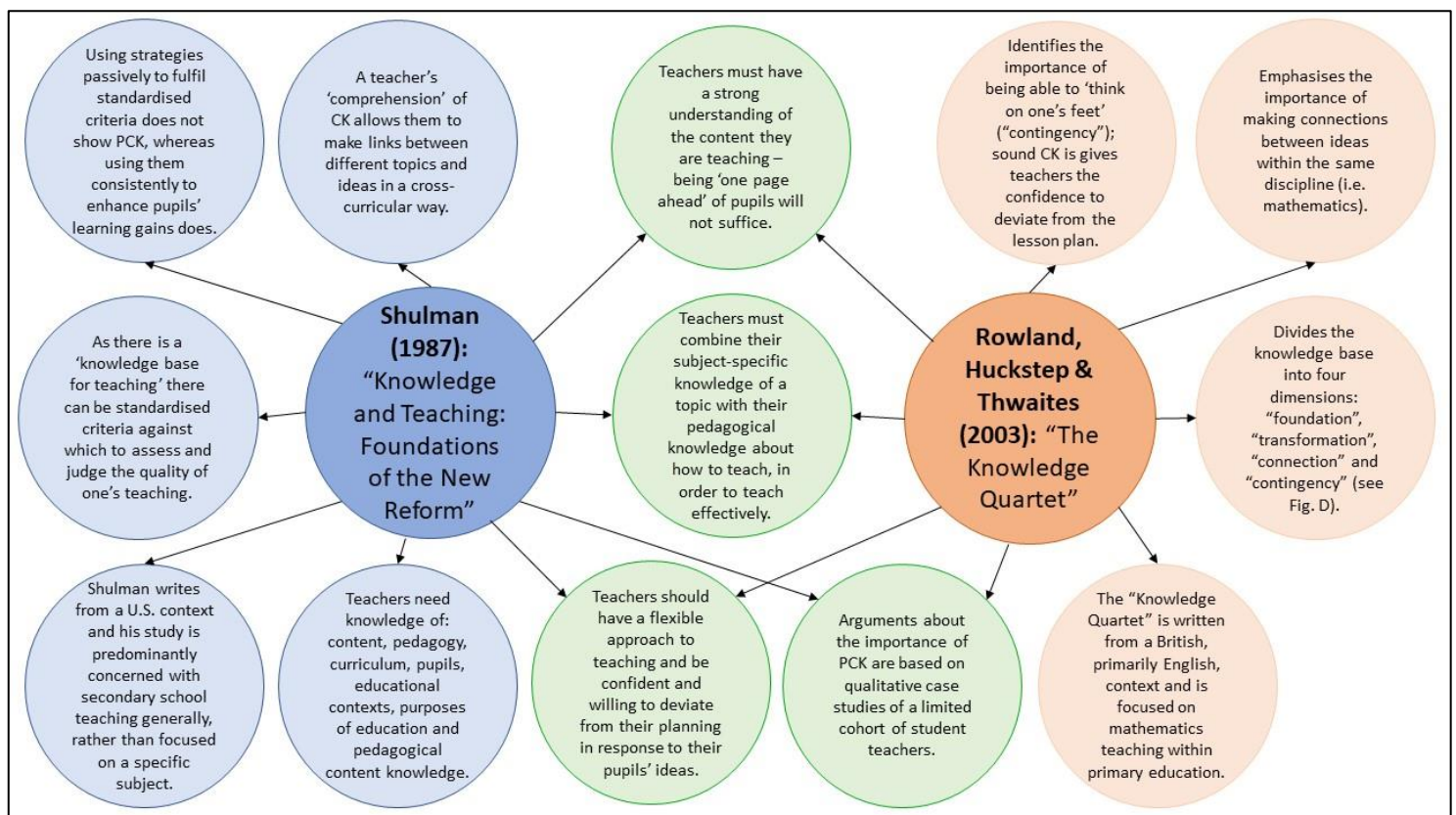


Fig. C. A comparison of Shulman's (1987) and Rowland et al.'s (2003) theories about subject knowledge for teaching.

Rowland et al. (2003) propose four dimensions of teachers' knowledge: 'Foundation', 'Connection', 'Transformation' and 'Contingency' (see Fig. D.). Like Shulman, they identify that teachers' knowledge surpasses subject-specific CK: it is about making CK accessible to all pupils. CK is part of 'Foundation' knowledge upon which teachers' other knowledge depends; this also incorporates pedagogical knowledge and beliefs about how the knowledge relates to children's learning (Rowland et al., 2003). Both texts promote deep understanding: teachers should have secure CK and an understanding of the principles underpinning that knowledge, rather than simply being 'one page ahead' of students in the textbook.

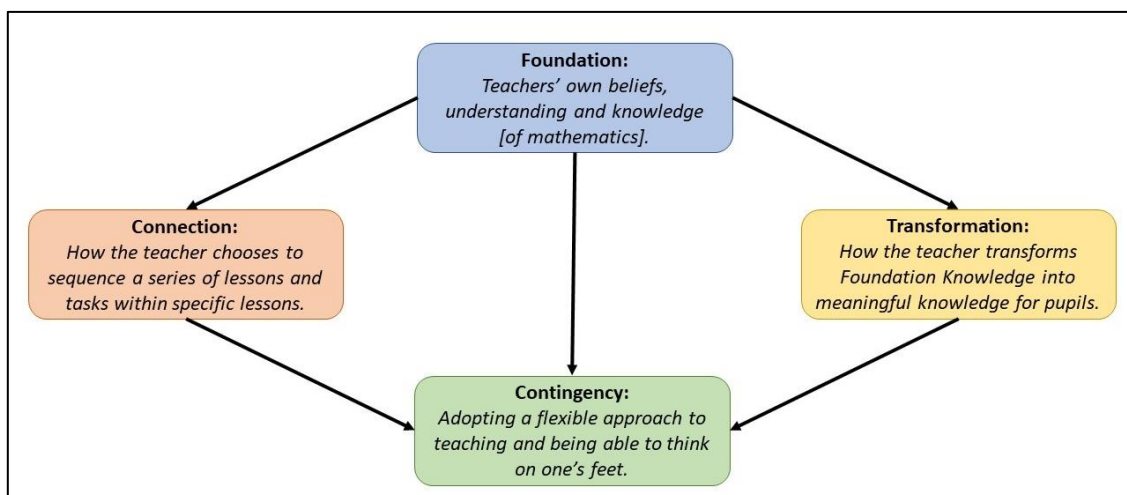


Fig. D. The elements of "The Knowledge Quartet" (Rowland et al., 2003).

Whilst Shulman (1987) identifies 'Transformation' as selecting a singular *representation* of knowledge appropriate to learners' needs, Rowland et al. (2003) consider it as a *re-presentation* of knowledge – depicting the same knowledge through different approaches to embed understanding. Both concur that knowledge for teaching incorporates the careful selection of teaching methods to suit pupils' needs, yet they differ regarding the form of these teaching methods. Shulman (1987) suggests that most teaching involves a text, an

inappropriate approach for children still developing early reading skills, whilst Rowland *et al.* (2003) advocate the use of concrete manipulatives and real-world contexts for problem-solving. Likewise, Grigg endorses 'outstanding teachers transform[ing] knowledge using equipment such as base-10 apparatus correctly to explain number processes' (2015: 188). This variance is perhaps because Shulman writes from a secondary context whereas the others examine primary education, these learners thus have differing needs.

Teachers' CK involves 'seeing connections between and among ideas' (Barnes, 1989: 16). This reflects Rowland *et al.*'s (2003) definition of 'Connection' – the linking of mathematical concepts through coherent planning and teaching. However, Shulman (1987) argues this is 'comprehension' of how CK links interdisciplinary topics and ideas. Drawing upon Donaldson's (2015) identification of three "Cross-Curricular Responsibilities": Literacy, Numeracy and Digital Competence, Wales implemented the *Literacy and Numeracy Framework* (LNF) (Welsh Government, 2015) and the *Digital Competence Framework* (DCF) (Welsh Government, 2016) to develop core skills across the curriculum. Therefore, whilst Rowland *et al.* (2003) advocate connections between concepts within mathematics, Wales is developing cross-curricular mathematical thinking which gestures towards Shulman's (1987) view of connectivity; for example, mathematical data-handling may be applied to scientific investigation; position and direction to geographical map-reading skills; or shape to creative development.

Hattie emphasises that 'a typical lesson never goes as planned' (2012: 30); Rowland *et al.* (2003) refer to this as 'Contingency' – the ability to think on one's feet and deviate from lesson plans in response to children's ideas – and it is recognised that this child-centred approach, whilst important for effective teaching, may cause anxiety for teachers especially if they possess limited CK of

the topic. This may imply that CK underpins teachers' 'Contingency' knowledge, a timely consideration as the forthcoming curriculum envisages more child-initiated learning so that 'every child and young person benefits from personalised learning' (Welsh Government, 2014: 7).

Trainees knowledge about teaching practices is informed by their childhood school experiences (Ball, 1988), but with the new Welsh curriculum, my biographical knowledge of instructional methods may become outdated. This could force a re-evaluation of the strategies that I deem appropriate to teach content and alter my pedagogical knowledge, as Welsh education continues to depart from the didacticism I encountered as a child, towards a Constructivist approach where the child learns through experience (Piaget, 1926). Grigg echoes this contention, recognising that 'striking the balance between teacher input and pupil-led inquiry' as one of teaching's greatest challenges (2015: 193), suggesting that this is a common weakness of teachers' knowledge.

In contrast to the literature previously discussed, Hattie contends that 'teachers' knowledge has little effect on the quality of student outcomes' (2012: 28). For Hattie (2012), teachers' beliefs regarding whether pupils have understood the content taught are quintessential for effective teaching. Hattie suggests that outstanding teachers possess well-integrated knowledge of pupils' prior understanding, based on their monitoring and assessment; this enables teachers to differentiate lesson content so that all pupils can progress. It could be suggested that this is necessary knowledge for teaching, despite Hattie's rejection of the value of teachers' knowledge.

Although Hattie only considers qualified teachers, he recognises that his philosophy has implications for trainees, who he considers should be more concerned with knowing 'the effect they have and less about knowing who they are and how to go about teaching' (2012: 36). Whilst Shulman (1987) and

Rowland *et al.* (2003) propose that knowledge of learners is important, neither prioritise assessment for learning and measuring teacher impact, as Hattie does. Assessment measures are changing, with all compulsory school age children being assessed against the same “Achievement Outcomes” (Donaldson, 2015). This may impact how children’s understanding of lesson content is identified as teachers must assess against new criteria.

Coe *et al.* believe that ‘student progress is the yardstick by which teacher quality should be assessed’ (2014: 2). Moreover, they argue that, to deliver excellent teaching and learning, trainee teachers must ‘understand the ways in which pupils think about the content, evaluate thinking behind non-standard methods and identify pupils’ misconceptions’ (2014: 44). This amalgamates Hattie’s focus on pupil understanding with Shulman and “The Knowledge Quartet’s” requirement of strong CK and PCK, adding the need for teachers’ self-evaluation of their methods of instruction. In the following section, I consider my experiences as a trainee teacher in light of the literature that I have discussed.

Analysis and Evaluation of Knowledge

Teachers ‘have difficulty in articulating what they know and how they know it’ (Shulman, 1987: 6) yet this assignment demands I do just that. I now examine my existing knowledge base – both CK and PCK – in relation to the “Cross-Curricular Responsibilities” of Literacy, Numeracy and Digital Competence (Donaldson, 2015). I also consider how Donaldson’s (2015) “Four Purposes” for the new curriculum may impact upon knowledge for teachers in Wales.

My PTE took place at a small primary school in South Wales. The school has 180 pupils aged three- to eleven-years-old; 22% of children are identified by the school as having special educational needs (SEN) and 50% are eligible for free school meals, 31% above the national average (Estyn, 2018a). Few pupils speak English as an additional language and very few speak Welsh at home (Estyn,

2018a). Estyn (2018a) identifies the teaching of Welsh language as a development area for the school, citing teachers' limited confidence and knowledge as a barrier, which emphasises the importance of teacher subject knowledge for providing excellent teaching and learning. I was placed in a Year Two class of 31 children: the school identifies 23 pupils as having SEN and one child has a Statement of Educational Need.

The UK has a legacy of low achievement in numerical, literacy and technical skills (Grigg, 2015) and 40% of Welsh children reach secondary school with a reading age less than their actual age (Estyn, 2012), suggesting that these skills are not adequately developed under the current curriculum arrangements. There are 'a range of competencies and skills which are foundations for almost all learning and are essential to being able to participate successfully and confidently in the modern world' (Donaldson, 2015: 39) which the new Welsh curriculum highlights through its three "Cross-Curricular Responsibilities".

As a Literature graduate, this curriculum area may hold my strongest and deepest CK, but the subject will be reshaped to form one of six new 'Areas of Learning and Experience' (AoLE): 'Languages, Literacy and Communication' (Donaldson, 2015) under the new curriculum. This AoLE incorporates the learning of Welsh language - a priority for Welsh Government (2017) who target a million Welsh speakers by 2050. I currently have a beginner's proficiency in Welsh, but my literature review demonstrated that successful teaching and learning necessitates strong understanding. This marks a difference in my knowledge for this AoLE between English and Welsh: I am confident teaching written and spoken English but lack the corresponding skills for Welsh. To address this, I am attending Welsh lessons, observing Welsh usage in school and researching Welsh language patterns relevant to my teaching and incorporating these into my lesson plans (see *Appendix One*).

I rely on modelling and flashcards to develop pupils' spoken Welsh. Whilst commended for this during a formative assessment (see *Appendix Two*), I recognise that I struggle to teach Welsh dynamically across the curriculum due to my limited repertoire of teaching strategies. In the Foundation Phase, children have limited Welsh themselves, so on PTE, I have learned the requisite knowledge ahead of lessons to transmit this to pupils. However, teaching goes beyond 'telling pupils what they need to know' (McDiarmid *et al.*, 1989: 193); it must enable pupils to develop flexible understanding of the subject-matter (Nickerson, 1985). I am currently unable to teach this deep understanding, which Shulman (1987) argues is necessary for pupils to transfer it between contexts, because I currently lack the required CK.

My weak CK, and consequently PCK, will soon become clearer when I teach Year Six. These children are more competent in Welsh than myself and the curriculum necessitates teaching more complex skills, for example 'mutate correctly after prepositions and pronouns' (Welsh Government, 2016a) which I have not acquired. I must, therefore, upscale my CK for Welsh by familiarising myself with the appropriate curriculum guidance *now* so that I am secure with the language expectations *before* I begin lesson planning.

I now analyse a mathematics lesson on rotation and direction which I taught on PTE (see *Appendix Three*), as a case study for examining my knowledge in this area. I taught this session outside, encouraging pupils to draw on the playground as they rotated. Having worked in Year Two in England for several years, I have encountered this knowledge being taught before which informs my chosen 'instructional representations' – the models used to convey subject-matter to the learner (McDiarmid *et al.*, 1989: 193). Schwab (1978) notes that these are chosen based on a teachers' combined knowledge of subject-matter, learning processes, pupils and context; four facets of the knowledge base identified by Shulman

(1987). My choice of representation is based on my historic observations that pupils find it challenging to transfer their understanding of clockwise and anticlockwise to their own movement.

Visualisation is *essential* for teaching geometrical concepts because children need to 'see to think' (Mooney *et al.*, 2009: 71) in order to develop and communicate their knowledge of such concepts. Likewise, mathematical understanding develops more quickly and securely when children have an audience other than the teacher (Hansen, 2011): my whole-class input allowed children to monitor and assess each other's understanding. By applying my knowledge as Schwab (1978) suggests, I overcame barriers to learning and enabled all pupils to meet the lesson objective (see *Appendix Four*). McDiarmid *et al.* discern two sources which underpin a teacher's selection of instructional representation: 'one outside themselves and one within' (1989: 196); in this lesson I used external resources such as the Foundation Phase Outcomes (Welsh Government, 2015) to develop my Success Criteria, alongside internal experiences based on reflections of previous lessons.

Yet, my experiences prior to PTE are within the English context and curriculum. In England, for Year Two, rotation appears only on the National Curriculum for Mathematics (Department of Education, 2014), whereas in Wales it is both part of Mathematical Development (Welsh Government, 2015) and the LNF (Welsh Government, 2016a). This means that in Wales this knowledge should be embedded across the curriculum, not just in discrete mathematics lessons: something I failed to do on PTE. Donaldson notes that teachers must provide opportunities for children to 'reinforce and use their numeracy skills in different contexts' (2015: 40) in a 'natural and authentic, rather than add-on' manner (2015: 69), suggesting children should develop these skills across the curriculum only when they organically fit. I had not considered this prior to PTE, which shows

my need for development within three areas of knowledge defined by Shulman (1987): curriculum, pedagogy and the educational context within which I teach.

Additionally, this suggests that I must plan in a cross-curricular way to identify opportunities for cross-curricular skills development. Retrospectively, the children could have practiced following rotational directions on a local walk, developing their mathematical skills within a real-world context. In the next phase of PTE, when I am teaching Year Six long division and fractions, I will consider ways in which this knowledge, albeit taught in discrete numeracy lessons, can be transferred to other curriculum areas. I must carefully consider this in relation to my CK, PCK and curriculum knowledge so that I am prepared to deliver good mathematics teaching across the curriculum when I return to school.

Likewise, I must incorporate Information and Communication Technology (ICT) across the curriculum to develop digital competence. This is vital because ICT permeates children's lives through leisure, entertainment, communication, networking and gathering information (Donaldson, 2015). Although my PTE school has a specialist ICT teacher, all staff are responsible for developing digital competencies (Donaldson, 2015). I struggled to identify opportunities for developing digital competence across the curriculum; this is partly due to my weak CK and that of support staff, who avoided implementing planned ICT activities. To develop my CK I must understand technical vocabulary within the *DCF* such as 'algorithm', 'metadata' and 'permissions' (Welsh Government, 2016b) as this inhibits my development of curriculum knowledge and CK.

Several schools successfully upskill staff and pupils' digital competence by creating 'a clear vision of digital learning' and mapping the *DCF* across the curriculum to 'ensure that there are no gaps in provision and sufficient progression and continuity' (Estyn, 2018b). I am unaware of such arrangements

within my school – it is my responsibility to acquire this knowledge to develop a clearer understanding of required CK for teaching digital competence effectively.

Shulman (1987) proposes that flexible communication of knowledge which accounts for pupils' learning needs establishes an inclusive learning environment. This was particularly apparent during PTE owing to the high level of SEN within the class and is demonstrated in my teaching of a Personal and Social Development lesson, and the formative feedback I received (see *Appendix Five*). I adapted my explanations and questioning with ease to meet the needs of individual children. This, according to Shulman, suggests that I have not only 'depth of understanding' but also 'a broad liberal education' which enables me to impart differentiated explanations (1987: 9).

However, in this lesson my timings went awry as I had not anticipated the additional time added by these variations in explanation. Therefore, whilst my PCK allowed me to take a flexible approach, my presentation of this knowledge did not adhere to the constraints of the lesson. For Rowland *et al.* (2003) this points to a defect in my 'Transformation Knowledge' whereas Shulman (1987) would emphasise my inability to express CK within defined classroom routines. Incorporating realistic timings into my planning is necessary to regulate the pace of my lessons (Snow & Campbell, 2017: 66) – currently my timings are based on how long I think an activity *should* take rather than how long it *will* take my pupils to complete.

Furthermore, under the new curriculum, the purposes of education (recognised by Shulman (1987) as a distinct area of teacher knowledge) are changing. Of "The Four Purposes" of the curriculum (see *Fig. E.*), the ambition that all children become 'enterprising, creative contributors who are ready to play a full part in life and work' (Donaldson, 2015: 29) directly affected my PTE.

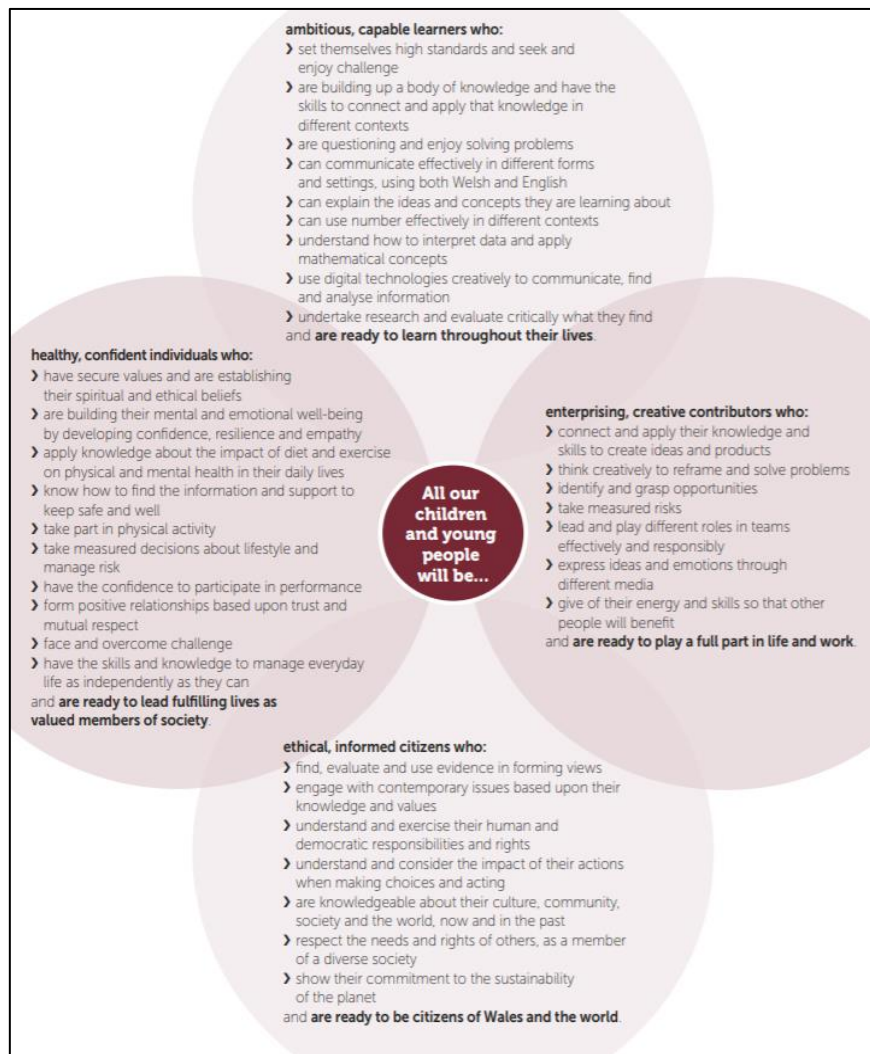


Fig. E. "The Four Purposes" of the new Welsh curriculum (Donaldson, 2015: 31).

Pupils designed, created and sold products at a Christmas market, handling money and calculating profits and loss. Planning this experience was challenging, particularly under the current curriculum arrangements. 'Entrepreneurial skills should be infused throughout the curriculum and pedagogical approaches' (Estyn, 2018c), suggesting a shift within the knowledge base, for myself and other teachers across Wales, as new knowledge, skills and instructional representations redefine Welsh education. In some respects, this reflects the "Cross-Curricular Responsibilities" as Enterprise allows children to 'connect and apply their knowledge or skills to create ideas or products' (Donaldson, 2015: 29). Estyn's

(2018c) findings - that pupils make very good progress in literacy, numeracy and ICT through Enterprise - support this.

However, Enterprise is taught as a discrete subject in my PTE school and I found it challenging to determine success criteria for tracking pupil progress in these lessons due to its cross-curricular nature. I identified my lack of knowledge in this area, leading me to undertake further research (see *Appendix Six*). “Enterprise Troopers”, a competition for Welsh primary schools to showcase entrepreneurship, has developed an Enterprise Skills Framework like the *Skills Framework for 3 to 19-year-olds in Wales* (Welsh Government, 2008). In future, I will incorporate this knowledge into my success criteria for Enterprise lessons.

Additionally, Enterprise is a child-led experience; although I recognise that some cognitive psychologists believe that children make sense of the world through self-initiated exploration (Piaget, 1926) and that the teachers should be ‘facilitators rather than instructors’ (Grigg, 2015: 137), I struggled to relinquish control and allow children to undertake Enterprise activities holistically (see *Appendix Seven*). This demonstrates a weakness in my PCK as I could not reconcile my CK with pedagogical knowledge which determines that I should guide, rather than dictate, the direction of learning.

Donaldson claims that good teaching ‘encourages children to take increased responsibility for their own learning’ (2015: 69) but also ‘means employing a blend of approaches, including direct teaching’ (2015: 65). This suggests that within the new curriculum, there is scope to blend both approaches to enable good teaching and learning. For Enterprise, I need to increase my confidence in knowing when to guide and when to step back. I will develop this by undertaking research into the application of child-led learning and reflect upon this within my own and others’ teaching, thus identifying good practice and enhancing my PCK.

Conclusion

My reflections suggest that understanding my knowledge base is essential if I am to become an excellent teacher. Arguably, 'knowledge' means something unique to every person; we all think differently and possess different knowledge which accounts for the disparities encountered within my literature review. Despite these diverse views, the knowledge base for teaching appears to incorporate, amongst other things: understanding the content being taught; general pedagogical knowledge; the ability to combine pedagogy and content to teach in an accessible way for all students; knowledge of curriculum, its purposes and proformas for learning; recognition of pupil progress and the assessment measures which determine this; and the ability to adapt teaching in light of child-led inquiry.

I examined my knowledge, identifying strengths (including my CK for English teaching, my PCK for PSD teaching and my ability to adapt explanations to meet the needs of pupils), and weaknesses (such as CK for Welsh language and ICT, PCK related to "Enterprise" and contextual knowledge related to the timings and pace of my lessons). I have proposed remedies to my weaknesses including research into CK for Welsh and ICT, specifically learning subject-specific vocabulary, and incorporating realistic timings into lesson plans.

I also argue that the new curriculum means that knowledge for teachers in Wales is on the precipice of change. This curriculum reform will alter teachers' knowledge required in many areas including: knowledge of curriculum purposes and aims, assessment requirements and the CK and PCK needed to teach new AoLEs. Teachers must modify their knowledge base now, in order to deliver the quality teaching and learning which the children of Wales deserve.

It is useful for trainee teachers to extend their subject knowledge because 'the neophyte's stumble becomes the scholar's window' (Shulman, 1987: 4). As a PGCE student, I am simultaneously a neophyte teacher and a scholar. By

reflecting upon my 'stumbles', I have gained crucial insight into what the knowledge base for teaching means to me and my professional development. Shulman's assertion seems to imply that this point in my fledgling career is, therefore, optimal for conducting such a reflection.

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Appendices

Appendix One: “Vocabulary” section of lesson plan for mathematics lesson on Tuesday 20th November 2018.

Resources/ Key Vocabulary
Resources: Shape flashcards in English and Welsh. Bilingual word mats. Plastic 2D shapes. Worksheets. Shape property cards [for Spheres]. Vocabulary: symmetry, line of symmetry. Square/ sgwar , triangle/ triongl , rectangle/ petryal , circle/ cylch , oval/ hirgrwn , star/ seren , heart/ calon . Sides, vertices, properties. Dyma.... [This is....] Pa siap ydw hwn? [Which shape is this?] Welsh Language Incidental Phrases: tri, dau, un. Dim sharad - no talking Dwylo i fyny - hands up mae hi'n amser tacluso - it is tidy up time mae hi'n amser cinio - it is dinner time cinio - (hot) dinner brechdanau - sandwiches (own lunch) barod? - ready? eisteddwch ar y carped - sit on the carpet mae hi'n amser chwarae - it is play time bore da/prynhawn da blant - good morning/afternoon children

Appendix Two: Formative feedback from university tutor for mathematics lesson on Tuesday 20th November 2018.

S4: Welsh Language Standard

Excellent

- **Comments and Evidence**
- **Targets for improvement and suggested ways forward**

You have made an excellent effort to respond to your target and use more incidental and topic based Welsh. Your use of Welsh today was excellent . You taught bilingually when appropriate and the children also recorded the names of their shapes in Welsh . You carefully plan for the use of Welsh in your lessons .

Appendix Three: Lesson plan for mathematics lesson on Wednesday 12th December 2018.

Name of Trainee:		Session ref: (1) Numeracy 9.30-10.30	Date: Wednesday 12th December 2018	Class: Year 2	Foundation Phase Session Plan
Personal Target:	S1.3. Demonstrate combinations of professional characteristics which aim to motivate and inspire learners and secure their intellectual and personal development. S2.4. Understand how learners' physical, intellectual, linguistic, social, cultural and emotional development can affect their learning. S3.2.3. Assess learners' progress accurately using the Foundation Phase Outcomes. S3.2.4. Identify and support MAT learners, and those who are working below age-related expectations, those who are failing to achieve their potential in learning, and those who experience behavioural, emotional and social difficulties.		Number of learners: 31	Age: 6 and 7	
Learning objectives/intentions:	WALT rotate 2D shapes.	Success Criteria	FPO3: They move in given directions. FPO4: They make whole and half turns. FPO5: They recognise half and quarter turns and that a quarter turn is a right angle. FPO6: They relate right angles to full, half and quarter turns.	Meeting learners' needs:	CH working in "set" ability groups for Maths. 1-1 support for FG-E. Differentiated focus tasks based on CH's target FPO as a wide variance in the level of understanding expected across FPO3-6.
Introduction		Main activities		Resources/ Key Vocabulary	Assessment for Learning (strategies and opportunities)
Carpet Activity (9.30-9.45) If the weather is dry then this activity will be completed on the yard with chalk; if it is raining then the chairs will be pushed back and the CH will complete this activity on the carpet. Show CH video of clockwise/anti-clockwise: https://www.bbc.com/bitesize/dips/sjybt9j6 . Ask CH to stand up (if outside they will draw on playground with chalk as they move). Give CH instructions to turn a whole/half/quarter in a clockwise or anticlockwise direction. Use this to assess understanding. Once CH are sat down show them a 2D triangle. Explain that I want to know what this triangle will look like after it has been rotated a half turn clockwise. Ask CH to give suggestions. Repeat for rectangle - 1/4 turn anti clockwise.		Trainee focused task: <i>Prisms/Pyramids:</i> Work through a couple of examples on the whiteboard of rotating shapes. Tell CH that if you are turning one quarter you are turning by something called a right angle. A half turn is equal to 2 right angles. How many right angles will be in a three quarter turn? A whole turn? CH to complete rotation sheet - concrete shapes will be on the table for those who need a visual/tactile resource to help them. Additional adult tasks: <i>NM, Cylinders:</i> Use concrete shapes with children to explore turning whole and half turns. Get CH to notice that the shape looks the same after a full turn and flips after a half turn. CH to complete sheet with support as needed. <i>LC, Spheres:</i> Play "Simon Says" with CH to get them to make whole and half turns (in either direction), move forwards, backwards, sideways. Take photos to put in books and write a note explaining whether the CH are confident moving in given directions and making whole/half turns.		Resources: chalk (if outside), worksheet, concrete 2D shapes. Vocabulary: rotation, clockwise, anticlockwise, quarter, half, whole, turn. Welsh Language Incidental Phrases: tri, dau, un. Dim sharad - no talking Dwyllo i fyrr - hands up mae hi'n amser taduso - it is tidy up time mae hi'n amser cinio - it is dinner time cinio - (hot) dinner brechdanau - sandwiches (own lunch) barod? - ready? eisteddych ar y carped - sit on the carpet mae hi'n amser chwarae - it is play time bore da/prynhawn da blant - good morning/afternoon children Dewchi mewn yn dawel - come in quietly Grandewch - listen Edrychwch - look Meddyliwch - think ... os gwelch yn dda - ...please Gwaith da - good work Ymdrech dda - good effort	RAG score based on observations throughout the lesson. CH to complete smiley-face self assessment in line with school policy and give a reason why (if appropriate).
Plenary: If time, play a game of "Simon Says" as a class before Amser Chwarae to further assess CH's understanding of direction and rotation.		Independent learning opportunities: When not working with an adult CH to complete EPIC plans/challenges.			
Curriculum coverage (range and skills):					
Foundation Phase Framework: Mathematical Development>Using Measuring Skills>Area and Volume, Angle and Position Recognise half and quarter turns, clockwise and anti-clockwise.					
Foundation Phase Framework: Mathematical Development>Using Measuring Skills>Area and Volume, Angle and Position Recognise that a quarter turn is a right angle.					
Foundation Phase Framework: Mathematical Development>Using Measuring Skills>Area and Volume, Angle and Position Use mathematical vocabulary to describe position, direction and movement.					
Foundation Phase Framework: Physical Development>Skills>Personal Gradually improve their control and use of different shapes, levels and directions of travel and movement.					
Foundation Phase Framework: Language, Literacy and Communication Skills>Oracy>Developing and Presenting Information and Ideas>Listening Follow and create their own action commands.					
Literacy (LNF):			Numeracy (LNF): Using Measuring Skills>Area and Volume, Angle and Position Recognise half and quarter turns, clockwise and anti-clockwise. Using Measuring Skills>Area and Volume, Angle and Position Recognise that a quarter turn is a right angle.		
DCF:		Thinking - Show curiosity and explore everyday stimuli. Apply numeracy skills to other curriculum areas. Choose from given options what to do and how to do it. With support, follow the chosen process.		ESDGC	YCC - Use of Welsh incidental language.

Appendix Four: Student tracking for lesson shown in Appendix Three. All names have been removed due to ethical considerations.

Tracking Sheet: Mathematical Development		
	Date: 12.12.18	
Student	L.O. To rotate shapes.	Next Step
Pupil 1		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 2		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 3		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 4		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 5		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 6		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 7		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 8		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 9		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 10		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 11		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 12		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 13		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 14		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 15		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 16		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 17		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 18		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 19		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 20		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 21		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 22		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 23		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 24		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 25		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 26		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 27		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 28		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 29		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 30		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.
Pupil 31		1 Transfer knowledge of clockwise and anticlockwise to turning by 90 degrees.

Appendix Five: Formative feedback from senior mentor for Personal and Social Development lesson on Monday 10th December 2018.

S1: Professional Values and Practice

Excellent

- **Comments and Evidence**
- **Targets for improvement and suggested ways forward**

You have progressed extremely well during the first half of your practice showing a great deal of independence in all areas of teaching. You have got to know our pupils very well; you demonstrated that very well today by adjusting questions and language to suit the needs of all learners today. Your ARC reflections are outstanding, you are ensuring you reflect on your practice and the impact you're having on learners. Your PDP is developing very well and it's pleasing to see you proactively ensuring you're covering all aspects of the profile. Make sure you find the time this week to visit Flying Start to view their Foundation Phase Profile arrangements. Many thanks for assisting with the school nativity. As a next step, I would encourage you run or assist with a lunchtime or an after school club during the second half of your practice.

Appendix Six: Assisted Reflective Conclusions (ARC) on my subject knowledge of "Enterprise".

Assisted Reflective Conclusions (ARC) Model

Date: Wednesday 21st November 2018 .

Critical incident (focus): Contributing to, and observing, whole class enterprise planning. CH were on carpet reflecting on their mind maps from Monday and deciding as a collective what to make/do for enterprise.

Experience	
Feelings "What are your feelings regarding the experience?"	It was really interesting to observe how the school encourages CH to become enterprising, creative contributors. I was pleased that all CH's ideas were shared for consideration and the teacher used effective questioning to lead CH to decide collectively which ideas were viable in this context and how to realise this.
Remember and Understand "Can you list the aspects of the learning experience that went well?" "What were the elements of the learning experience that were disappointing?"	I was able to learn about encouraging enterprise at a school recognised by Estyn for their excellence in the area. I was able to support in finding solutions to problems and leading questioning when D.A. was called out of the room. I was limited in how I could support due to my limited teacher subject knowledge in the area.
Evaluate and analyse "What will you keep the same to ensure effective teaching and learning in the future?" "What was the cause of the most important disappointing element?"	Learning good practice by observing outstanding teaching and learning. Incorporating some of the high level questioning into my own teaching. I could see the obvious benefits of this type of learning and am keen to incorporate this into my future teaching where appropriate. My lack of knowledge in this area of learning.
Conclusions and actions "What are your possible solutions to the disappointing issues identified?" "What will you do next?"	I need to research this area e.g. by finding out the sorts of skills developed through enterprise. I will do research before planning my own sessions related to enterprise for next week.
Transformed experience	

Appendix Seven: Assisted Reflective Conclusions (ARC) on struggling to not interfere with child-led learning.

Assisted Reflective Conclusions (ARC) Model

Date: Wednesday 28th November 2018

Critical incident (focus): Working on enterprise projects - working with select CH to create posters/signs using an online app. I really found it difficult to not interfere with their designs so that they would sell.

Experience	
Feelings "What are your feelings regarding the experience?"	I found it frustrating that I could not interfere with the CH's work to correct typos, remove clip art so writing could be seen etc. I recognised the importance of this being the CH's own work but I struggled to balance this against my own knowledge that the general public will not purchase products with lots of mistakes.
Remember and Understand "Can you list the aspects of the learning experience that went well?" "What were the elements of the learning experience that were disappointing?"	The CH used the ICT program (which was new to them) under my guidance. I used questioning to get CH to think about sensible changes they could make to their designs - '1/2 of the CH edited their designs accordingly and learnt about the importance of keeping things you are going to sell professional. I found it disappointing that some CH did not respond well to the questioning and made designs that had mistakes or were too cluttered. Because of my own lack of subject knowledge surrounding enterprise I was unsure how to move things forward whether to change the designs myself (at the risk of damaging CH's esteem) or leaving them and risking them not selling.
Evaluate and analyse "What will you keep the same to ensure effective teaching and learning in the future?" "What was the cause of the most important disappointing element?"	The CH enjoyed using ICT and learnt new skills which they wouldn't have if designing on paper - I will endeavour to use more ICT in my lessons. I will also use questioning to try to lead CH to their own conclusions as I feel this leads to more meaningful learning than if I had directly told them to make changes.
Conclusions and actions "What are your possible solutions to the disappointing issues identified?" "What will you do next?"	I need to research more into teacher subject knowledge in this area e.g. "Enterprise Troopers" website. I also need to re-read what Donaldson says about enterprise as "Enterprising, creative contributors" is one of the four core purposes of Donaldson's new curriculum for Wales so it is important I am competent to teach in this area.
Transformed experience	