Trialling the use of the Knowledge Quartet as a framework to facilitate beginning teacher learning on one ITE programme in Wales

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ABSTRACT

Trialling the use of the Knowledge Quartet as a framework to facilitate beginning teacher learning on one ITE programme in Wales.

This study involves trialling a tool called the Knowledge Quartet (KQ; Rowland et al., 2005) on a postgraduate initial teacher education programme in Wales and reports on perceptions of its use to facilitate lesson planning, analysis and feedback and reflection. The study aims to answer the following questions:

1. In what ways is use of the KQ framework perceived by Lead Mentors, tutors and student teachers to be effective as a tool in facilitating beginning teacher learning in the areas of:

a) Lesson planning

b) Lesson observation analysis and feedback

c) Reflection

2. In what ways is use of the KQ framework perceived to be a challenge?

Findings are from two action research cycles, involving semi-structured interviews (with two Lead Mentors, a university tutor and ten science student teachers) and an analysis of six science students' portfolios (containing mentors' lesson observation and feedback reports and associated student lesson plans and reflection). The tool is perceived to be effective in several ways. Firstly, the KQ tool is perceived to structure and support student planning by breaking down, categorising and raising awareness of underlying teacher knowledge. Secondly the tool is perceived to get easier to use over time. Thirdly, there is a perception that using the tool contributes to mentor professional development. Fourthly, the tool is perceived to be most helpful to beginning teachers; assessment requirements to use the KQ to structure reflection

ensured its use by all science student teachers in this study. However, there are also challenges. More education and time may help embed its use (this study was affected by Covid-19). To make use of the tool more educative, during mentor development, mentors could be encouraged to share experience of using the KQ and lead an exploration of how its use can support beginning teachers towards meeting the Teaching Standards.

Trialling the use of the Knowledge Quartet as a framework to facilitate beginning teacher learning on one ITE programme in Wales.

Section 1 Introduction

1.1 Rationale for the focus of this study, reasons for my interest in the issue and why it is important in my teacher education context

This dissertation involves a trial of a framework, called the Knowledge Quartet (KQ, Rowland et al., 2005), to facilitate beginning teacher learning on a postgraduate certificate in education (PGCE) programme in my initial teacher education (ITE) context.

In September 2019, as part of ITE reform in Wales (Welsh Government, 2017; Furlong, 2015), my university began delivering a suite of new undergraduate and postgraduate programmes. The new courses, accredited through the Education Workforce Council (EWC) Wales, on behalf of the Welsh Government, are meant to raise educational standards in the principality (EWC, 2019; Senedd Research, 2017). Run in equal partnership with schools (Furlong, 2015; Mutton et al., 2018), with support from the local educational consortium, the programmes are designed to offer high quality ITE and an inquiry-led approach to learning (EWC, 2019; 2015; 2018). The programmes are inspected annually by Her Majesty's Inspectorate in Wales, Estyn (2020).

On the new PGCE secondary programme, lesson planning, formal lesson observation and critical reflection are the main tools used to develop student teachers' practice, underpinning inquiry-led learning. Formal observations by mentors and tutors are an opportunity to discuss

strengths and areas to develop in which the student teacher is expected to take the lead (X, 2019), supporting their continuing inquiry into practice.

Previously my university had no specific framework to help analyse lesson plans, teaching observations or structure student reflection; teaching observation analysis led to grading against the Teaching Standards (Welsh Assembly Government, 2009; Welsh Government, 2019a). The KQ framework is a means of analysing teacher knowledge used to plan and teach lessons and was initially designed for primary mathematics (2005); subsequently it has been used to analyse teacher knowledge in other subjects, such as science (Rowland & Turner, 2007). The framework is also considered to support critical reflection (Rowland, n.d.).

As a university PGCE secondary teacher educator (tutor), with specialism in science, I first came across the KQ framework as part of my reading about teacher knowledge for my assignment, on the Master's in Teacher Education programme at Oxford University (Author, 2019). I found that using the KQ helped to focus my feedback on the beginning teachers' developing knowledge rather than on numerical grading against the Teaching Standards (Welsh Assembly Government, 2009; Welsh Government, 2019), something I found liberating (Author, 2019) in a high accountability environment (Estyn, 2020). I thought the KQ could offer mentors and tutors a means of analysing practice, in order to offer feedback to help students bridge the gap between what they can do and Wales's new Teaching Standards (Professional Standards for Teaching and Leadership, Welsh Government, 2019a). I also considered the KQ framework could support student reflection on teaching, in order to inform their subsequent planning. Moreover, with the advent of a new National Curriculum

in Wales (Welsh Government, 2019b), I considered the KQ framework could also support mentors, tutors and student teachers to discuss planning for the new curriculum.

Furthermore, ITE managers, in my context, considered that a trial of the use of the KQ could support mentor and tutor professional development and offer a reflective instrument to support student teachers' developing practice, aspects the EWC had advised ITE centres across Wales to develop further. I was given their permission to undertake the project.

Notwithstanding that this action research study was affected when school placements were terminated (due to coronavirus disease, Covid-19), the findings from this study will be of interest to other teacher educators in Wales, and beyond, who wish to analyse, support and offer quality feedback on beginning teachers' developing teacher knowledge, as well as support novice beginning teachers' planning and reflective skills.

1.2 Research aims and questions

This study aims to trial the use of the KQ and explore perceptions, in my context, of the effectiveness of using the tool to support beginning teacher learning, attempting to answer the following research questions:

1. In what ways is use of the KQ framework perceived by Lead Mentors, tutors and student teachers to be effective as a tool in facilitating beginning teacher learning in the areas of:
    a. Lesson planning
    b. Lesson observation analysis and feedback
    c. Reflection

2. In what ways is use of the KQ framework perceived to be a challenge?

In summary, in this section, I have described my rationale and interest in trialling use of the KQ in my context, outlined my research questions and noted my research was affected (due to Covid-19). The next section presents the literature review, exploring beginning teacher learning and how this is facilitated in ITE.

Section 2 Literature Review

This literature review seeks to address the research questions (1.2). Section 2.1 looks at the literature in ITE and attempts to set the programme studied here into a wider literature of international trends in teacher education. Section 2.2 explores what teacher knowledge beginning teachers learn during ITE and associated analytical frameworks, making a case for using the KQ tool, before Section 2.3 explores the mentor's role in facilitating beginning teacher learning and helpful dispositions to learning. Strategies used to facilitate learning in ITE (including lesson planning, lesson observation analysis, feedback and student teacher reflection) are also explored in this section, before mentoring in my context is examined. A final brief section (2.4) considers how change in practice can be embedded in ITE.

2.1 Initial Teacher Education

2.1.1 Becoming a professional teacher and qualified teacher status

Teaching is conceptualised as a profession (Shulman, 1986; Varkey Foundation, 2018) and ITE programmes are often how novices start their development into professional teachers. Such programmes may be perceived as gatekeepers, ensuring only those who reach a certain standard are let into the profession. However, in its widest sense, ITE is more than a means of filtering out poor teachers. With a view to a long-term career, ITE programmes involve not only supporting and challenging beginning teachers to acquire the knowledge and skills to become effective teachers, but encouragement onto a path of continued effective professional learning and development (Whitty & Furlong, 2017).

Globally, there are several routes to becoming a qualified teacher (The National Recognition Information Centre, NARIC, 2012). In keeping with NARIC (2012), the Organization for Economic Co-operation's (OECD) teaching and learning international survey (TALIS, 2019a), found that most countries require a degree to become a qualified teacher.
In Britain, becoming a teacher can be school-based and school-led, involve graduate programmes or involve a partnership between universities and schools (with learning at both university and school). In Wales, undergraduate and postgraduate university ITE programmes are offered in 'equal partnership with schools' (EWC, 2019, p1) and aim to offer the best 'from universities and schools' through inquiry-led learning.

Studying to become a teacher is still often referred to as 'teacher training'; in Britain, students make applications for 'teacher training' (Universities and Colleges Admissions Service, 2019). However, globally, the move away from the term 'training' to 'education' in ITE is deliberate and emphasises that becoming a teacher involves more than practical, systematic training (O'Neill, 1986; Furlong, 2015), it involves knowledge and learning. The clinical practice model (Hayward, 1997; McIntyre, 1990; EWC, 2019) underpinning ITE in Wales (and my PGCE programme) is more sophisticated than mere learning by imitation and aims to develop a range of knowledge, as well as the use of critical thinking and reflective skills in order to take the best from current research and practice to inform, inquire, research and form theories about what should take place in the classroom.

During ITE, beginning teachers are normally assessed to ascertain their teaching competency. The knowledge and learning required to be a qualified teacher is often articulated in professional Teaching Standards which lead to certification ("Learn how to become", 2020) and, in Britain, qualified teacher status (QTS, Department for Education, 2013; Welsh

Government, 2019a). Demonstrating competency against professional Teaching Standards during formal assessments is, therefore, essential for beginning teachers.

The deliberate emphasis on pedagogy in Wales's new professional Teaching Standards (Welsh Government, 2019a) is meant to ensure that all teachers are able to validly explain their pedagogical decisions (Furlong, 2015; Whitty & Furlong, 2017), to support pupil achievement and progress. However, a significant issue for student teachers' learning is the challenge for experienced teachers to articulate the 'why' of their practice (Brown & McIntyre 1993; Childs & McNicholl, 2015). The levels of self-awareness required and the challenge to mentors and beginning teachers to think beyond institutional or national ways of doing things should not be underestimated. These ideas will be returned to in Section 2.3.3.

The next section considers how beginning teachers progress during their time in ITE, with reference to their knowledge development and focus on pupils' learning.

2.1.2 Beginning teacher progression in learning during ITE

Teaching can appear to be easy, however, some (Coe et al., 2014; Burn et al., 2015; Barnett & Hodson, 2000) consider it to be a complex undertaking. In order to maximise the knowledge gained during ITE, an awareness of beginning teacher progression in learning may be helpful.

According to Fuller & Bown's model (1975; similar to Kagan's staged model ideas, 1992), beginning teachers pass through certain stages as they learn to teach; these include being concerned with self, then the management of activities or tasks before finally turning more

full attention to the pupils' learning needs. In their more fine-grained analysis of beginning teacher stages (carried out in Wales on a one-year primary postgraduate programme), Maynard & Furlong (1995, p.73) include further stages that can be related to knowledge development and a focus on pupils' learning:

- "Being idealistic" - the beginning teachers tend to focus on personality and professional relationships rather than on developing knowledge.
- "Survival" – students may feel overwhelmed by all the knowledge and skills they must develop.
- "Preoccupation with how they will deal with difficulties" – they are not yet focused on meeting pupils' learning needs.
- "Plateau" – they have developed some knowledge and skills but pupils' learning is still superficial.
- "Moving on" – they more accurately critically reflect on the impact of their developing knowledge on the pupils' learning and use this more skilfully to plan pupils' further learning.

Movement between the above stages may occur as student teachers' beliefs (Tsai, 2002; Luft & Roehrig, 2007) develop towards more pupil-centred thinking. Similar to Fuller & Bown's model (1999), Maynard & Furlong's stages (1995) may be viewed as linear, although the authors were careful to point out that the stages are "not fixed" (p.72).

However, some beginning teachers may exhibit sophisticated practice early on in their development, as found by Mutton et al. (2011) and Burn et al. (2003) in their longitudinal study of 36 postgraduate beginning teachers' lesson planning and follow-up of 24 into the first two years of teaching. As explained by Korthagen & Kessels (1999), in their argument

for a new pedagogy in ITE, this may be related to beginning teachers' underlying beliefs and educational experiences being more attuned to current teaching and learning theory. Burn et al. (2003, p.315) found that beginning teachers were "concerned with pupil progress" and learning from the start of their practice, although less likely to know how to deal with difficulties or issues. Burn et al's (2003) research is critical of staged models that may neglect the complexity and individual nature (Hagger et al., 2008) of beginning teacher learning.

Korthagen & Kessels (1999) also caution there must be meaning for the individual beginning teacher if learning is to take place. (For example, unless beginning teachers realize the significance of developing their teacher knowledge, they may pay little attention to it.) Being responsive to the individual learning needs of a large cohort of beginning teachers is challenging. Wales's clinical practice models of ITE (EWC, 2019; McIntyre, 1990) offer theoretical teacher knowledge and practice at pre-determined points, with progression in learning over time. This whole cohort teaching may not always coincide with individual learner needs or interest (Korthagen & Kessels, 1999), however, the emphasis on inquiry-led learning (2019; 1990), together with mentoring and university tutor support means the model may offer students support with individual, as well as general developmental needs, so that students can develop general teacher knowledge, as well as situation-specific knowledge (1999) required for efficacy.

The next section examines teacher knowledge in more detail.

2.2 What beginning teachers learn on ITE programmes and how this can be analysed and developed

Given my intervention is focused on facilitating beginning teachers' learning, this section focuses on what knowledge they need to learn to become teachers and frameworks that analyse that knowledge.

2.2.1 Teacher Knowledge

In the literature there is no agreement on what constitutes teacher knowledge (OECD, 2019b; Kind, 2009; Hume & Berry, 2011). The OECD (2019b) report that, during ITE, student teachers are given opportunities to learn about different knowledge; this may include subject knowledge, content knowledge (what to teach) and effective instruction. Thirty-four years ago, Shulman (1986, p.9 - 10; 1987) conceptualized teaching to involve "subject matter knowledge (knowledge of the subject, concepts etc.), knowledge of the curriculum and pedagogical content knowledge" (PCK). Shulman's original conception of PCK was:

> The most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others. Understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of the most frequently taught topics and lessons.
>
> (Shulman, 1986, p.9)

Over the intervening years, there have been several studies and reviews of teacher knowledge, including in the specific context of science teaching (Brickhouse et al., 1987; Carter, 1990; van Driel et al., 1998). PCK is perceived to be an important aspect of teacher knowledge in these studies but there are debates about the exact nature of PCK. Lee & Luft's (2008) literature review outlines eight different aspect of knowledge that make up PCK, although almost all include Shulman's (1986, p.9) original knowledge of representations and strategies and knowledge of student learning, conceptions, misconceptions and common pupil errors. Hashweh (2005) would agree that PCK involves several factors and in his literature review and reconceptualization of PCK, notes the importance of re-teaching lessons and learning and consolidating PCK over time, supported by post-lesson reflection or discussion (Tang & Chow, 2006). Some researchers (Cochran et al.,1993, p.263) go further and have altered the term itself, referring to "pedagogical content *knowing*" to show that knowledge is not static. The background of the researcher (practitioner or pure scientist) may also determine the perspective and the extent to which various knowledge factors (from knowledge of general pedagogy to knowledge of context and assessment) are included or emphasised in conceptual models (Lee & Luft, 2008; Childs & McNicholl, 2015).

However, subsequent writers in science education quickly adopted and developed PCK. Childs & McNicholl (2015, p.109), in their exploration of task design in science, like Barnett & Hodson's 2000 study of beginning science teachers' knowledge, draw attention to the fact that PCK is a "highly contextualised and complex form of professional knowledge" that is hard to pin down and may also be topic or subject specific. According to some, subject matter knowledge is a fundamental part of PCK (Shulman, 1986; 1987) and globally most ITE programmes offer subject knowledge development (OECD, 2019b), however, there are also exceptions (for example, Belgium, Turkey, Iceland etc., 2019). Subject knowledge

development is considered (2019b; Mikeska et al., 2017) to be most effective when it is combined with pedagogical knowledge (knowledge of how to teach) and practice, however, over time, subject knowledge seems to become less important (Gess-Newsome & Lederman, 1999). This may be related to the idea that correct subject knowledge is foundational (OECD, 2019b) but is not sufficient to ensure effective teaching (Childs & McNicholl, 2015; Edwards, 2015).

In Ben-Peretz's (2011) literature review of teacher knowledge research between 1988 and 2009, interpretations of teacher knowledge are found to be context dependent. University tutors are perceived (2011) to interpret teacher knowledge more broadly, whilst school-based students and mentors are more likely to confine it to content knowledge. According to Childs & McNicholl (2015, p.109), PCK is just one facet of experienced teachers' knowledge and "may be more than the sum of its parts". On the other hand, Wiliam (2016) an influential leader in educational assessment, considers it possible to be an effective teacher without fully grasping PCK. The value may not be whether teacher knowledge exists or not (Gess-Newsome, 1999) but in using categorizations to help discuss beginning teachers' development. The teacher knowledge literature (Ben-Peretz, 2011; Rowland, 2013) makes links between teacher knowledge and action, meaning an analysis of the former may allow for an interpretation of the latter. It may, therefore, be helpful to discuss teacher knowledge categorization or frameworks in order to further examine what beginning teachers learn to become expert teachers.

2.2.2 Teacher knowledge frameworks

Having discussed the issues and tensions in defining one aspect of teacher knowledge important in science education, PCK, this section looks at a range of frameworks researchers have used to analyse teacher knowledge, including PCK (the first framework came from research involving experienced teachers, the second with input from teacher educators working with beginning teachers and the third from research on beginning teachers in ITE). It ends by arguing for and discussing the Knowledge Quartet as the framework adopted in this study.

Barnett & Hodson (2000) offer a teacher knowledge framework developed using grounded theory, involving interviews with six middle school science teachers in Canada (note they were not novice beginning teachers). They (2000, p.445) consider teacher knowledge to comprise "academic and research knowledge, PCK (Shulman, 1986), knowledge of context (Childs & McNicholl, 2015) and professional knowledge", the latter including knowledge of the individual pupils and official duties that brings together aspects of teacher knowledge from school, university and the wider educational context.

Bransford et al. (2005) offer a teacher knowledge analysis framework based on research into the developing expertise of teachers and the personal experience of the researchers as teacher educators supporting beginning teacher learning. The framework (2005) is based on Shulman's conceptions of PCK and a practitioner view of teacher knowledge that is pupil focused. The framework (2005) outlines the importance of knowledge (Burn et al., 2015, p. p.17 – 18) of:

a. "learners and learning,
b. subject matter and curriculum goals
c. teaching".

In their discussion of beginning teacher learning, Burn et al. (2015) point out that each knowledge category in Bransford et al.'s (2005) framework involves several important aspects of practice and also draw attention to the interplay between the categories being highly complex and challenging for the beginning teacher, something also acknowledged by Barnett & Hodson (2000). Use of the term class management (rather than the currently accepted behaviour management) illustrates that the framework's detail may require updating; over fifteen years have passed since Bransford et al.'s paper.

Another teacher knowledge framework published during the same year is the 'Knowledge Quartet' (KQ). Produced using grounded theory and case study analysis of video tapes of primary school mathematics student teachers teaching towards the end of ITE (Rowland et al., 2005), it attempts to classify the vast array of potential knowledge a beginning teacher has to contend with (Burn et al., 2015). As with the other frameworks, the aim is to make "tacit or intuitive knowledge visible" (Burn & Mutton, 2015, p.222) so that it can be "shared and developed". A key aspect of the original study (2005), is that the authors did not use the KQ to grade or assess the student teachers; the emphasis was on dialogue and discussion to improve teaching and learning, as it will be used too in this study. Although initially developed for elementary mathematics teaching, the KQ has subsequently been used in other phases (secondary) and subjects (Rowland & Turner, 2007; Rowland, n.d.).

According to the KQ framework (Rowland et al., 2005; 2009), teacher knowledge is made up of four quadrants or domains. Table 1 presents the definition of each knowledge base drawing on Rowland et al.'s (2005) work and other key authors.

Foundation Knowledge – **beginning teachers' possessed knowledge** of subject, content, curriculum goals, pupils, context and how pupils learn (Burn et al, 2015). Similar to Shulman's (1987) discussion of comprehension, this knowledge may be influenced by beliefs and will vary between beginning teachers depending on their experiences (Burn et al., 2003; Childs & McNicholl, 2015). It includes (Rowland, n.d., para.1; Weston et al., 2013) "awareness of purpose, identifying pupil errors, concentration on procedures, overt use of subject-specific terminology and adherence to textbooks" (although the latter may be less important in the context of science, where adherence to textbooks may be less widespread). If beginning teachers' content knowledge is weak then teaching is also weak; 'they misinform pupils' (Rowland, 2013, p.17). On the other hand, Barnett & Hodson (2000) caution that having good subject knowledge alone is not sufficient for	**Transformation Knowledge – "knowledge in action" (Rowland et al., 2005, p. 261)** "demonstrated by beginning teachers in their planning and teaching practice" (Rowland, n.d., para. 2). Closely aligned to PCK it encompasses Shulman's ideas (1986; 1987) of how expert teachers draw on knowledge of representations (such as analogies), strategies, a "deep knowledge of student learning, conceptions and misconceptions" (Shulman, 1986, p.9) to "make decisions about what to teach and how to teach it" (Bishop & Denley 2007, p.16; Lee & Luft, 2008). It includes the transformation of foundation knowledge (including knowledge of pedagogy, research and classroom, Barnett & Hodson, 2000) through choice of "demonstrations, representations, examples and use of instructional material" (Rowland, n.d., para.2; Weston et al., 2013). This knowledge enables an effective teacher "to judge matters such as depth of treatment and contextualization" (2000, p.433; Berliner,

effective science teaching; it can result in didactic teaching.	2004). An exploration of beginning teachers' pedagogical choices, by tutors and mentors, can promote "critique and reflection" (Rowland, 2013, p.23). The generality of the quartet means there is scope to encompass other aspects such as assessment strategies under this section that were not fully drawn out in Rowland et al.'s original work. The skilful use of assessment for learning may be an indicator of a highly specialized base of PCK, supporting beginning teachers to critique and develop their practice. Another indicator may be teachers' in-depth subject knowledge (Bishop & Denley, 2007, p.14) that allows the use of anecdotes or stories to extend and transform subject knowledge into activities that interest and motivate learning.
Connection Knowledge - knowledge in action for coherence (Rowland, n.d.). This allows task design to make use of structural links (Rowland, 2013) to previous learning (including across the curriculum) and future work to produce a strong narrative within	**Contingency Knowledge – knowledge in action** – allows beginning teachers to use "insight" and to respond in the moment to pupils' questions, ideas, behaviour, motivation or issues, such as pupils not comprehending or finding the work too easy

and between lessons (Barnett & Hodson, 2000), "connecting procedures, concepts, anticipating complexity, making decisions about sequencing and conceptual appropriateness" (Rowland, n.d., para.3; Weston et al., 2013). It can support progression in learning through "increasing cognitive demand" (Rowland, 2013, p.25). In the context of Wales, this knowledge base may become increasingly important with a new inter-connected curriculum (Welsh Government, 2019b). This area of knowledge could also be used to discuss how student teachers are developing their own teacher knowledge through inquiry and connecting it with research and school experience (Schneider & Plasman, 2011), in order to support further research informed-practice and career-long professional learning.	(Rowland, n.d., para.4; Weston et al., 2013). It also allows beginning teachers to exploit learning opportunities or to respond when "tools or resources" are unavailable (n.d., para.4). It relies on beginning teachers' knowledge of 'alternative ways of representing subject knowledge' (Barnett & Hodson, 2000) and is more than "being able to think on your feet", it involves actions that respond to learning needs (Rowland, 2013, p.26). Teacher action can be planned but learners' response is less easy to control (2013). To be able to skilfully respond in the moment, in complex situations with conflicting goals (Clark & Lampert, 1986 in Korthagen & Kessels, 1999) requires beginning teachers to use a range of both concrete and abstract teaching and learning knowledge in an educative way, staying calm during the process (Rowland, n.d.); being anxious or less confident may impact how this knowledge is deployed.

	Contingency knowledge has links to Berliner's (2004) ideas of increasing teacher expertise and flexibility. More advanced novice teachers may demonstrate more flexible and adaptive knowledge and behaviour; this may mark them out as being further along in their development than their peers (Berliner, 2004; Schneider & Plasman, 2011).

Table 1: KQ, adapted from Rowland et al., 2005, p.265 – 266.

There may be some intimation in the KQ of incremental development as student teachers gain knowledge in theory, make this knowledge accessible to pupils, connect the knowledge and place it in the bigger picture before skilfully taking advantage of learning opportunities in order to keep the lesson running smoothly and optimise learning. However, in reality, the framework and the knowledge categories are interrelated (Rowland, 2013) and can be used holistically (Rowland et al., 2005) or to focus on one or two areas of knowledge at a time; according to Rowland (2013, p.18), all four aspects of teacher knowledge "surface in novices' teaching".

The framework gives mentors a means to work alongside the students to help them to discover and test their developing educational knowledge against accepted theories (as advocated by Korthagen & Kessels, 1999) and to challenge students' preconceptions and prior experiences of teaching and learning in a professional learning community of practice (Stoll et al., 2006; Lave & Wenger, 1991). Joyce & Showers (1988 in Korthagen & Kessels,

1999, p.5) explain that students require “coaching support to connect educational theory to their actions when they encounter them in practical situations”.

Although the KQ re-terms aspects of knowledge into more broad, general themes, like Bransford et al.’s framework, the KQ is not meant as a checklist but rather as a supportive tool (Burn et al., 2015) that promotes discussion and dialogue of how to solve classroom dilemmas or identify strengths, in order to develop and support effective practice in an incremental way. (This is also in keeping with John, 2006, and his argument for a dialogic model to improve beginning teachers’ planning.)

The knowledge required for a lifetime in teaching is vast and the goal of ITE is not to impart a fixed or complete set of knowledge (OECD, 2019b), rather programmes may use frameworks, like the KQ, to highlight, discuss and support teacher knowledge development, for example, during inquiry-led learning (McIntyre, 1990; Toon & Cordingley, 2020), so that ITE becomes the foundation for career-long learning and teacher knowledge development. ITE programmes may be at their best when developing flexible, adaptive practitioners to meet pupils’ needs; those with rich contingency knowledge.

However, using the KQ does have some challenges. Firstly, as can be seen from table 1, the KQ is cognitive and does not deal with the emotive and affective knowledge of teaching. In their literature review of theoretical perspectives of science teacher development, Fazio & Melville (2008) note the interconnectedness of cognitive and social knowledge development, explaining that teachers often need to manage both emotive and cognitive change as they alter beliefs. Secondly, Rowland et al.’s (2005) KQ does not mention assessment, a key aspect of pedagogy in Wales and beyond (Welsh Government, 2019a; Wiliam, 2016).

Thirdly, in focusing on beginning teacher knowledge, the KQ could be perceived not to focus on pupils' learning needs. Arguably, using teacher knowledge skilfully is about responding to pupils' learning needs but there may be a need to make this explicit. The generalisability of the KQ means it has the potential to encompass and address all the above aspects, but it may need to be extended to take them into account.

To explore further how beginning teacher learning is facilitated in ITE, the next section will consider the role of the mentor, the strategies they use and helpful beginning teacher dispositions to learning.

2.3 The means of facilitating beginning teacher learning

2.3.1 The role of the mentor

To help beginning teachers make meaning of their experiences in a helpful and developmental way, ITE students are normally provided with support from experienced teacher educators; more knowledgeable others. Teacher educators in Wales, on PGCE secondary programmes, fall broadly into the following types:

- Mentor - an experienced teacher, normally someone in the same (or closely related) subject;
- Senior mentor – overall responsibility for mentoring at the school (Estyn, 2018);
- Lead Mentor – overall responsibility for mentoring in a cluster of schools;

- Tutor – a university lecturer who may visit student teachers on school placement, co-observe teaching (with the mentor) and offer support and challenge to both students and mentors.

As explained by Loughran (2006), in his study of the pedagogy of teacher education, simply observing experts teaching is not enough; giving students more classroom experience alone does not support their development (Schneider & Plasman, 2011; Barnett & Hodson, 2000). Mentoring is considered key to supporting students to "connect theory to their actions in practical situations in which they encounter problems" (Joyce & Showers, 1988, p.5 in Korthagen & Kessels, 1999). Mentors provide beginning teachers with day to day support. In their discussion of successful ITE partnership working, van Velzen & Timmermans (2014) point out that mentors may act as critical friends, making teacher knowledge visible by modelling practice, scaffolding and taking a collaborative approach to support the development of beginning teachers; they also assess outcomes and give feedback.

Additionally, beginning teachers must be receptive to learning (Korthagen & Kessels, 1999). Hagger et al. (2008) would agree. Hagger et al. (2008, p.167), in their case study analysis of post-lesson interviews with 25 beginning teachers, conclude that beginning teacher learning comprises five dimensions: "aspiration, intentionality, frames of reference, response to critical feedback and attitude to context" and associated helpful orientations that support beginning teacher learning, such as welcoming feedback and being aspirational for themselves and their pupils.

Mentors who support and challenge beginning teachers towards positive learning dispositions, encouraging them to analyse their practice (rather than telling them) were found to support learning (Hagger et al., 2008; Estyn, 2018); this may be related to ideas of

beginning teachers as adult learners with useful prior knowledge (Burn et al., 2015; Loughran, 2000). Beginning teachers also need the freedom on ITE programmes to make mistakes and learn from them (Hagger et al., 2008); this may be easier in some school contexts than others and be dependent on the individuals involved. Beginning teachers require mentoring that is both individualistic (Hagger et al., 2008; Burn et al., 2003), context specific (Mutton et al., 2010) and supportive of adult, inquiry-led learning to prepare them for career-long learning.

2.3.2 Specific strategies used to facilitate beginning teacher learning

A key strategy to facilitate beginning teacher learning is collaborative planning with more experienced others, such as mentors and tutors. Beginning teachers may use lesson planning to articulate their thoughts about how to teach and support pupils' learning; mentors and tutors use these plans to check, discuss and support beginning teachers' development (Burn et al, 2015). Rowland et al. (2005) consider discussion to be key to beginning teacher development. Similarly in his longitudinal study in Hong Kong of four English second language teachers' use of an adaptive process, Gan (2018) considers collaboration with more knowledgeable others to be a key to teachers' development. Mentors may try to illuminate "implicit or difficult to see knowledge" by explaining their own rationale for teaching or offering further tasks that may provide beginning teachers with insight (Childs & McNicholl, 2015, p.120). Mutton et al. (2011), in their study of collaborative lesson planning, found beginning teachers learnt more in collaboration and discussion of rationale with others. Like Burn et al. (2008), in their discussion of supporting teacher professional learning, and John (2006), in his argument for improved reflection on lesson planning, collaborative planning

exercises and dialogue (as part of a professional community of practice, Lave & Wenger, 1991) may be necessary to support novices to gain insight into their own and others' practice.

Lesson study in ITE (Cajkler & Wood, 2015; Corcoran, 2011; Turner, 2008) is a method which includes collaborative planning and other key strategies which facilitate beginning teacher learning, such as observation, feedback and critical reflection on practice, that may offer such insight. Originating in Japan, Lesson Study can help make tacit knowledge clearer and also support improved understanding of pupils' needs (Dudley, 2013). (My ITE centre is also trialling the use of Lesson Study and beginning teachers involved in this study were tasked to use the KQ tool to help them reflect on their Lesson Study findings.)

Nevertheless, the challenge of making time for discussion and exploration of practice cannot be ignored. Studies have shown that teachers are extremely busy professionals (Coe et al., 2014; Brown & McIntyre, 1993) and that much time is required to discuss and develop beginning teachers' knowledge and practice (John, 2006). This can be ameliorated to some extent by encouraging peer discussion but on clinical models of ITE (Hayward, 1997; McIntyre, 1990), similar to the one in my context (EWC, 2019), there is an expectation that discussions will involve an experienced teacher with mentoring and coaching experience. The latter is deemed necessary as students, in general, can struggle to be critically reflective (Halpern, 1999; Clarke, 2014). Some beginning teachers have a tendency to be simply critical (sometimes as a form of learnt helplessness, Burn et al., 2015), others may overestimate the efficacy of their practice, rather than being critically reflective. Poor critical reflection can reinforce prejudice, institutional ways of doing things (Loughran, 2000) and may limit further development.

The quality of the mentoring offered can be a key determinant of beginning teachers' progress. As experienced teacher educators, Burn et al. (2015, p.56) advocate that mentors model an inquiring disposition that revels in learning and takes insight from the pupils, colleagues, the immediate context and beyond, as well as from valid research studies to come to conclusions about how best to teach in practice; although the challenge for the beginning teacher to do the same, using all the information in the moment should not be underestimated.

The next section explores mentor feedback and judgement, what constitutes effective feedback and challenges that can arise.

2.3.3 Feedback from mentors

Beginning teachers spend most of their time at school during university-style ITE in Britain. At school they are offered day to day support and challenge by mentors. As Estyn, in their latest thematic study into mentoring in Wales (2018) explain, the relationship between the mentor and student is a key influence on beginning teacher outcomes.

Mentors observe beginning teachers teaching and give feedback to support their learning. Similar to Estyn's (2018) recommendations for mentoring in Wales, Feeney (2007, p.191), in his case study of mentor feedback to students, states the "goal of feedback is to improve teaching effectiveness and pupil learning" and concludes that feedback outcomes should be based on "observable data, discuss teaching in terms of its effectiveness" in promoting pupil achievement or progress, using reflective inquiry to support further progress.

Martin (1995) in his analysis of videotapes of mentors giving feedback to students in England (numbers were not given) considered the best mentor feedback uses elements of counselling and leadership skills, judging the motivation and skillset of the students to help them to progressively become independent self-assessors. Rowland (2013) also considers the most important evaluation is self-evaluation by the beginning teacher themselves but that this can be "provoked and assisted" (p.40) by feedback from mentors. In their analysis of the role of dialogue in mentoring, Coombs et al. (2013, p.59) explain that it is through discussion and "filtering their experience through the lens of others' ideas" and knowledge that beginning teachers can make sense of mentors' feedback.

In her discussion of the purpose, expectations and tensions of giving feedback in ITE, Copland (2009) explains some student teachers find feedback, following teaching observations, to be the most useful aspect for their development. However, in her (2009, p.471) analysis of feedback given to beginning teachers "teaching English to speakers of other languages", Copland (2009) also noted others find it a trial leading them to "play the game" (p.471) to get through the process, giving the impression of engaging with reflective practice but in actual fact just giving answers they perceive their mentors wish to hear. Like Copland (2009), a quarter of a century ago, Martin (1995) and Feeney (2007), note that differing levels of maturity may explain why some find feedback challenging. Tang & Chow (2007, p.1067), in their study of 32 post-observation discussions (which they term a limited number) between in-service teachers and supervisors in Hong Kong considered an "asymmetrical power relationship" may underlie such behaviour and they discuss how peer or group reflection can remove the high stakes aspect of mentor feedback.

As Hattie (2012, p.129), a leader in education assessment points out, "feedback is powerful", but it can have both positive and negative effects. Another issue identified in the literature

(Estyn, 2018; Martin, 1995; Hagger et al., 2008) is some mentors' tendency to tell students rather than discussing feedback and promoting beginning teacher reflection. This could be related to time pressures but may also indicate the difficulty of explaining pedagogical decisions (Childs & McNicholl, 2015).

A further complication of trying to give feedback is presented when two people observe the same lesson. There is evidence (Coe et al., 2014) that they are likely to come to different conclusions, depending on, amongst other things, their focus; Hattie (2012) reminds us that feedback systems "thrive on errors" (2012, p.129). This may be the root of why some students consider the outcomes of their lessons in a very different light to the mentor or tutor who observes them (Burn et al., 2015). Agreeing a focus for feedback may be a necessary step (something my context has introduced this year).

There is also evidence from the literature that when students are graded, for example, against the Teaching Standards, their post-observation feedback can feel fraught, where any mistakes are not seen as learning opportunities but high stakes incidents that can lead to success or failure (Burn et al., 2015). Moreover, Schneider & Plasman (2011, p.532) explain that Teaching Standards outline what beginning teachers "should know and be able to do" but are "based on what is desired rather than on what is developmentally reasonable". Focusing on the Teaching Standards during formal observations may, therefore, constrain feedback necessary for beginning teacher learning and development.

Hobson & Malderez (2013) in their re-examination of two empirical studies of mentoring in England conclude that judgemental approaches ITE impede mentoring and threaten the learning and well-being of beginning teachers. A pre-occupation in assigning a grade or category may also be viewed as detrimental to students' progress if the focus is on the grade and not on the feedback (Hattie, 2012). It may, therefore, be most useful to follow Copland's

(2009, p.467) recommendation that mentors use "a range of feedback frameworks" to promote students' critical reflection and analysis of their performance in order to facilitate beginning teacher learning.

Feeney (2007), Martin (1995) and Copland (2009) in their research all consider what constitutes quality feedback and how it can be used to facilitate beginning teachers' learning and development. However, the answers are complex and less than clear cut. Much may depend on the student, the context and the stakes. Feeney recommends (2007) that mentors pose questions to promote reflective thinking. However, Burn et al. (2015) adds a note of caution; mentors' open questioning can also feel judgemental and asking questions must be done with sensitivity and self-awareness (2015).

2.3.4 Mentoring in my context

In my context of Wales, mentoring has been a feature of ITE university-led programmes for over a quarter of a century. Since 1992 (as in England), more time has been spent at school than university (24 weeks on teaching practice in school; 11 weeks at university).

Estyn's recent report (2018) into mentoring in ITE in Wales (heavily influenced by Hobson & Malderez's, 2013 research) attempts to have an agreed, national understanding of what is meant by mentoring in Wales and its purpose (the latter being perceived as key; Tang and Chow, 2006). It represents a shift in thinking in my context and is a conscious attempt to go further than England's mentoring report (Centre for Using Research and Evidence in Education, 2005) in order that the new ITE programmes in Wales improve their mentoring practice. Mentoring in Wales is now perceived (2018) to be less about judgement and more about supporting practice, incrementally towards independence and career-long ways of learning (Estyn, 2018; Clutterbuck, 2011, Hobson & Malderez, 2013). Estyn's

recommendations for ITE mentoring resonate with Tang and Chow (2006, p.1079) who advocate a "learning orientated assessment to support the construction of teacher knowledge".

On the new PGCE programme, students and mentors agree a focus for two formal observations per school placement. The student leads the post-lesson discussion with the mentor. The mentor writes up a summary of the feedback and agreed targets, noting the most relevant Teaching Standards; the student writes up an accompanying reflection on their development.

Tutors and mentors quality assure the mentoring process; tutors offer support to subject mentors and co-observe (with the mentor) the beginning teachers teaching at least once during each school placement. Mentors formally grade students against the Teaching Standards at the end of each placement.

The next section will briefly discuss how embedding change can be supported in ITE as, in this study, I am trying to embed using the KQ as a new framework to support beginning teachers' learning.

2.4 Embedding change to practice in ITE

As schools work in equal partnership with universities on ITE in Wales, it seems appropriate to consider the literature on how best to support and embed change to practice in partnership. Harris (2010), in her exploration of leading educational reform (including in Wales), like

Chapman (2015), in her exploration of outstanding practice in ITE in the Netherlands, recommends (2010) involving all stakeholders, school and university, in any change process.

According to change leadership and management literature in educational settings (Brundrett & Rhodes, 2011; Harris et al. 2018; Hoyle & Wallace, 2005), key to embedding new practice is having a clear purpose, clear communication and accountability; this may be even more crucial when working in partnership, across different contexts.

Boud (2007) and Nicol (2007) point out that accountability and assessment outcomes can drive change to practice. Harris (2010) on the other hand highlights social and emotional aspects that need to be taken into account. Awareness of self and others and the avoidance of harm may mean that the sustainability of change may rest on aspects such as personality and trust between partners (2010).

Change to practice in ITE may also involve offering education to school mentors and university tutors. Cordingley et al. (2015) in their literature review of professional development in schools, found interventions must be sustained to be impactful and embed:

> To be effective in producing profound, lasting change, professional development interventions had to be prolonged. The most effective professional development lasted at least 2 terms - more usually a year (or longer).
>
> Cordingley et al., 2015, p.12

Kotter (2012), also discussing change management strategies in educational settings, recommends identifying advocates who can lead and embed change. In ITE, it may,

therefore, be helpful to identify mentor advocates who can drive change to practice in the school context, encouraging them to work together with university tutors to deliver professional learning in partnership.

In the specific context of ITE, Chapman (2015, p.40) also advises a solution-focused approach to change in ITE practice, working from an emotionally aware perspective (as advocated by Harris, 2010). Based on the work of Lewis et al. (2011), Chapman (2015) advocates an approach that uses inquiry to identify what works well in partnership (this may include what works in assessment outcome terms, Boud, 2007), celebrating and building upon success, including through professional learning events. Underlying this approach is mutual trust, a shared overarching aim and clear communication in order to manage change (Kotter, 2012; Brundrett & Rhodes, 2011; Harris, 2010). Such a solution-focused approach (Chapman, 2015) may support an exploration of the outcomes of this trial and consideration of the KQ's possible further use in my context.

2.5 Summary of what has been learnt from the Literature Review.

During ITE, beginning teachers learn and develop teacher knowledge; this may help them towards meeting the Teaching Standards required for qualified teacher status. Although there are debates about the exact nature of teacher knowledge, with respect to my first research question, the KQ offers a framework that can be used by mentors, tutors and student teachers to facilitate beginning teacher learning by analysing developing teacher knowledge, although it may be most useful when combined with other frameworks. The KQ can also be used to facilitate the development of reflective skills, underpinning inquiry-led learning, that can inform subsequent lesson planning and teaching. Moreover, the KQ may also augment

collaborative planning exercises designed to give students insight into mentor teacher knowledge, thinking and practice, helping to illuminate mentor feedback (that, in turn, may support students' development of helpful dispositions to learning).

With respect to my second research question, there are some challenges to using the KQ. The original KQ does not deal with emotive aspects or assessment for learning; any version used in this study may need to be enhanced to include these aspects. It may also be important to make explicit links between developing teacher knowledge and meeting pupils' learning needs. As posing questions is seen to be part of effective mentoring and feedback, it may be helpful to devise associated questions to accompany the tool. Embedding the use of the KQ may take time; undertaking inquiry, finding what works well in partnership, identifying advocates, celebrating successes and taking a solution-focused approach to address challenges, may help embed use of the tool.

My research study will now seek to examine perceptions about the use of the KQ tool to facilitate beginning teacher learning in my ITE context, attempting to answer the following research questions:

1. In what ways is use of the KQ framework perceived by Lead Mentors, tutors and student teachers to be effective as a tool in facilitating beginning teacher learning in the areas of:
    a. Lesson planning
    b. Lesson observation analysis and feedback
    c. Reflection

2. In what ways is use of the KQ framework perceived to be a challenge?

The next section will discuss the methodology, the nature of the intervention undertaken, and the design of the research strategies used to investigate the outcomes to answer my research questions.

Section 3 Methodology

This section discusses the methodology and the nature of the intervention carried out during this study, the research strategies employed and considers ethical aspects.

3.1 Introduction to the methodology

Underlying my approach to the research are my philosophical ideas and assumptions (Denscombe, 2010, p.116; Grix, 2004; Thomas, 2009) that are 'reflected in the nature of my research questions'. My paradigm ("the ways I think about and research the world", Thomas, 2009, p.72) are related to my ontology (theories related to 'what exists in the natural world', Thomas, 2009, p.87; 2010) and my constructivist beliefs about social reality (2010, p.118; 2009). I believe that people construct their own reality, using their perceptions and perspectives, not mine. My theories of how reality is known (epistemology) mean I am an interpretivist (2010; 2009); I will try to make sense of participants' reality and come to know about it, however, this social reality is "subjective" (2010, p.121) and hence my research questions focus on the key stakeholders' (tutors, Lead Mentors and student teachers) perceptions of the use of the KQ to facilitate teacher learning. I am also an active participant in my research (as it is based in my context and on my practice) so that I can understand it as an interested insider researcher who interacts with the participants (Thomas, 2009). This means my research is not objective, my participants may act differently simply by taking part in the study (Hawthorne effect, Cohen et al., 2018) and another researcher may "provide a different account".

Trialling the use of the KQ tool is a 'what happens when' type of question and is appropriate to illuminate understanding of the usefulness or otherwise of the framework. As this study's research questions focus on perceptions and interpretations, qualitative research is appropriate (Denscombe, 2010). As a teacher educator and practitioner, I will use action research methodology (Thomas, 2009), as it is appropriate (Kemmis, 1988) for my interpretivist assumptions; the outcomes of this study will provide me with insights into practice to share with colleagues.

3.2 The nature of the intervention undertaken

This study discusses a trial undertaken on a PGCE secondary programme at an ITE centre in Wales. The trial encourages mentors, tutors and student teachers to use the KQ tool and reports on perceptions of its use, with the ultimate aim of more effectively facilitating beginning teacher learning in my context.

As mentioned previously (1.1), I had become interested in an analysis and reflection tool called the Knowledge Quartet (Rowland et al., 2005; Rowland, 2013) through my master's studies. I considered it encouraged useful discussions with beginning teachers in order to help them to explore and understand how they might develop their practice (Estyn, 2018; Hagger et al., 2008) without preoccupation with accountability measures, such as grading against Standards. Assessing against the Teaching Standards produces data for external accountability measures (Estyn, 2020), however, feedback may be distorted if time is spent on justifying grades. My intervention resonates with Winter's principles (Cohen et al., 2018, p.443) for action research that "risks disturbance" by critiquing a "taken-for-granted process"

(grading and assessment against the Teaching Standards, rather than a focus on how to bridge beginning teachers towards the Standards).

The next section discusses my action research in more detail.

3.3 Design of the research strategies

3.3.1 Action research

Action research is a form of systematic practitioner research (Ebbutt, 1985; Bell, 2010) and was first developed by social scientists, during the 1940s, to solve problems; the research leads to actions through a spiral of steps (Lewin, 1946; Cohen et al., 2018; Elliott, 1991). It is used in educational settings by practitioners as a "powerful tool for change and improvement" to student learning (2018, p.440) and as a "mode of learning" (Fazio & Melville, 2008, p.198) to "examine practice, gain a better understanding and take actions that impact or change practice through cycles of research" (Denscombe, 2014; Bell, 2010). Through analysis of perceptions in my teacher education context, I sought to come to a better understanding of the issue I had identified through my master's study (1.1). Using an action research model based on Lewin (1948, p.206), I sought to "reflect on practice to identify the initial issue, undertake fact finding, plan, take action, evaluate and amend the plan".

The study takes a practical action research approach (Cohen et al., 2018; Denscombe, 2010) that goes beyond technical action research (2010), as it aims to improve the effectiveness of mentors' and tutors' practice to support beginning teacher learning, coming to an improved

understanding of current practice and using professional learning and self-reflection to encourage further professional development.

My interpretivist viewpoint means I will use action research to interpret my findings in order to answer my questions, however, as my approach is not emancipating (Denscombe, 2010; Cohen et al., 2018), this study is unlikely to change ITE in itself or the organization. Rather it is meant, by critically reviewing the background literature, listening to the perceptions of others, to democratically and collaboratively enhance learning, coming to an improved understanding that can inform future practice.

By undertaking this research with school colleagues and my science student teachers my participation is collaborative and active (Denscombe, 2014; Adleman, 1993); as a science university tutor, I am also using the KQ. My involvement in the study (with knowledge of the context) means that the action research involves reflexivity (Cohen et al., 2018; Denscombe, 2010). To try to mitigate impartiality (2010) another tutor's viewpoint and knowledge of mentoring in my context has been sought.

By undertaking the research in a professional learning community (Stoll et al., 2006; Lave & Wenger, 1991), I hope to add to my ITE centre's knowledge and make my ITE colleagues "aware of the findings in my local context" (Fazio & Melville, 2008, p. 195). However, I must also be aware of limitations. It is difficult for such small-scale research to offer "genuinely new insights and be valid" (Cohen et al., 2018, p.455); as the data is restricted, I must be careful not to claim too much and must be alert to my personal biases. In order to improve the validity, I have sought not only to capture perceptions (through semi-structured interviews) but also evidence of the use of the KQ in mentors' lesson observation analysis

reports and student reflection. As the research relies on interpretation and is not objective (Kemmis, 1988), although it informs the knowledge and practice in my context there are limits to its generalisability, for example, to other ITE centres, although it may interest and encourage others to carry out similar research.

3.3.2 Action Research cycles

Data used in this study came from research conducted between January 2019 and March 2020. There were two cycles.

A cyclical, spiral process of action research (Denscombe, 2010), adapted from Lewin (1948, p.205 – 206; figure 1) was used to guide the study.

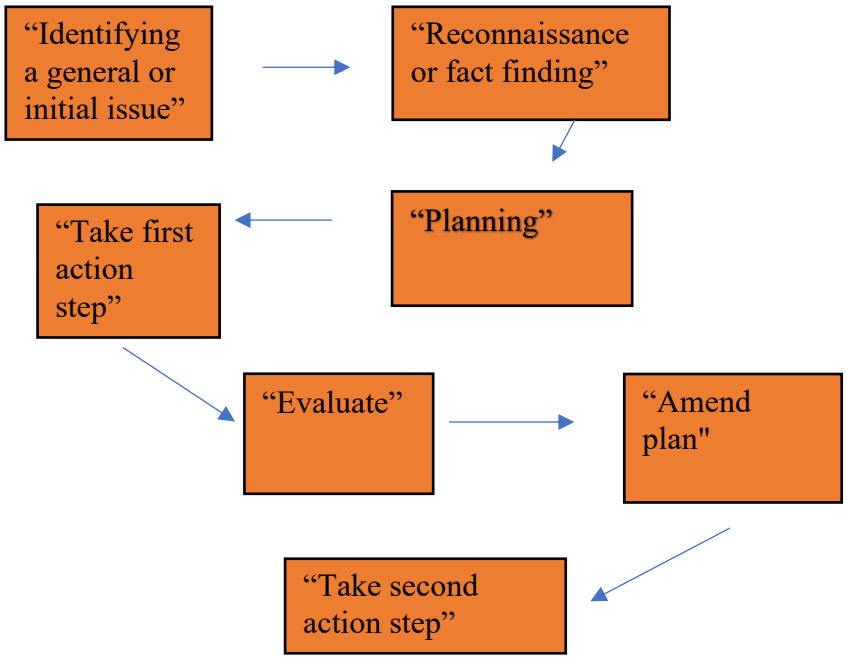

Figure 1: Action research spiral (adapted from Lewin, 1948, p.205 - 206).

Each stage in the spiral has a purpose: a consideration of professional practice led to the identification of the initial issue, fact finding (Elliott, 1991) and evaluation were then undertaken to inform planning and the first action step; evaluation of the consequences of that action, informed an amended plan and next action steps (Lewin, 1948). Table 2 gives a timeline for the action research. The timeline also notes steps that were not completed, due to Covid-19. Note, as it became apparent, school placement might be terminated, steps were taken to gain permission to collect and analyse science student teachers' critical portfolios, as a form of data.

Stage	**When**	**Participant(s),**
Identify initial issue: from my master's studies.	January 2019	I
Reconnaissance: Informal conversations about mentors' and tutors' use of analytical frameworks; their thoughts about grading students every two weeks.	January – July 2019	Partnership mentors, tutors and senior leaders in the ITE centre.

Reading literature on mentor feedback, the KQ and collaborative working.		
Planning and ethical permission, including decision to produce a collaborative version of the KQ.	June – July 2019	I
First action step: Introduction and discussion of KQ tool. Invitation to take part in the research.	July 2019	ITE partnership Lead Mentors and tutors.

Production of agreed version of the KQ with associated questions.	July 2019	ITE partnership Lead mentors and tutors.
Introduction to KQ during mentor development.	September 2019	All PGCE secondary mentors and tutors
Introduction to the KQ during PGCE session	September 2019	All PGCE student teachers
Invitation to science student teachers to take part in the research.	September 2019	Ten science student teachers.
Use of KQ	October – November 2019	All PGCE secondary mentors, tutors, student teachers.

Pilot interview Semi-structured interviews	November 2019 November 2019	University colleague who is also a mentor. Lead Mentor 1 (six years' experience as a mentor; specialism in science) Lead Mentor 2 (seven years' experience as a mentor; specialism in science) Tutor (nine years' experience; specialism in physical education and mentor development) Ten science student teachers (two physics, three biology and five chemistry).
Evaluate: Analysis of initial findings	December 2019	I

from semi-structured interview		
Amend plan: Production of an exemplar and further training planned. Plan to identify another of source of data should school placement be cancelled.	December 2019 January 2020	I I
Second action step: Exemplar reflection shared with science student teachers. Extra session given on using the KQ to reflect	January 2020	I and ten science student teachers

Permission to use students' portfolios gained.	January 2020	Six science students (two biology, two chemistry and two physics science student teachers.)
Students complete portfolios.	February 2020	Six science student teachers.
The following were not undertaken due to Covid-19: Reminder sent to all second placement mentors to use the KQ (with main points from the training, a copy of the KQ and collaboratively		

produced associated questions). Questionnaire to all PGCE mentors and tutors. Observation of mentors using the KQ to analyse lessons and give feedback.		
Evaluation: Analysis of critical portfolios	March 2020	I Six critical portfolios - two from biology student teachers, two from chemistry and two from physics student teachers.

Table 2 Action research timeline

3.3.3 First Action Research Cycle

The participants in the first cycle were PGCE secondary Lead Mentors, university tutors and student teachers. As an insider researcher (Thomas, 2009), I had easy access to these participants. A convenience sample (Cohen et al., 2018; Thomas, 2009) of the two Lead Mentors from schools (within a short travelling distance) and the ITE university tutor with responsibility for mentoring were chosen to trial using the KQ and share perceptions of its usefulness through a semi-structured interview. A convenience sample of all science student teachers (ten), with whom I work most closely (from the wider PGCE cohort) were also approached at the end a science session to take part in the study and semi-structured interviews.

The initial issue was identified through my master's studies (1.1). I then sought to understand the issue better through professional reconnaissance and fact finding (Lewin, 1948; Elliott, 1991). Through informal professional conversations, I sought to sharpen my understanding of the key issues and to find if any of my tutor or mentor colleagues perceived grading to distort feedback or were using any frameworks to analyse student teachers' planning or teaching. I also read around the area of teacher knowledge, mentor feedback and collaborative working. My findings informed partnership conversations about trialling a possible analytical framework and the efficacy of grading student teachers against the Teaching Standards on a fortnightly basis and the importance of dialogue in mentoring (Estyn, 2018). I was given permission to undertake the trial and seek ethical approval. In a subsequent partnership meeting, my ITE centre decided to stop grading student teachers fortnightly against the Teaching Standards and only grade once, at the end of each placement.

As part of planning (Lewin, 1948; Denscombe, 2010), I completed a research proposal and gained ethical permission to carry out the study. I then took the first action step

("participatory action", Denscombe, 2010, p.129; Adleman, 1993). The KQ was introduced, explored and discussed with the PGCE programme Lead mentors and tutors (those most heavily invested in ITE in my ITE partnership; Lead Mentors and tutors were also invited to take part in the research during this first introductory session.) Field notes (Cohen et al., 2018) were kept and an agreed collaboratively amended version of the KQ (Appendix A) with questions to prompt discussion (Feeney, 2007) was produced and put into the PGCE course handbook. I encouraged mentors and tutors to use the KQ, during a mentor development session. I then introduced the PGCE secondary student teachers to the KQ and they were tasked to use it to help plan lessons, undertake post-observation reflection and reflect on their Lesson Study findings, as part of their critical portfolio assignment. Science student teachers were also invited to take part in the research at the end of a science session.

All mentors, tutors and student teachers were given time to use the KQ and then two Lead Mentors, a tutor and ten science student teachers were interviewed, using semi-structured interviews, to help me to answer the two research questions and gain an understanding of perceptions of using the KQ to facilitate beginning teacher learning.

Mentors and tutors are busy people, therefore, I decided to conduct the intervention with experienced Lead Mentors and a university tutor with responsibility for mentoring, as those most likely to influence use of the tool and, as the most heavily involved and invested in the new programme and mentoring practice, the most likely to commit to try out the KQ and report back on their perceptions.

3.3.4 Second Action Research Cycle

The participants in the second cycle were the science student teachers and me. Following the science student teacher interviews in November, the plan and intervention were amended (Lewin, 1948) to give the science student teachers more help with using the KQ to reflect. I took the second action step of giving science student teachers an exemplar reflection (to analyse; Appendix B) and an extra session on using the KQ. As it became apparent that school placement might be terminated, in discussion with my supervisor, and with students' permission, a sample of six critical portfolios (the first two portfolios shared by student teachers from each of the three science disciplines; the portfolios include lesson plans, formal observation analysis and feedback forms and students' post-observation reflection) were analysed, as a form of data. An evaluation (Lewin, 1948) of the findings was then undertaken.

Plans to send a questionnaire to all mentors, tutors and student teachers on the PGCE, to involve everyone, including those who may be less engaged with the KQ to share their thoughts, were abandoned as school placements were terminated, due to Covid-19. This also meant I could not observe mentors (one from each PGCE secondary subject) using the KQ to analyse lesson observation and give feedback.

3.3.5 Collaborators

Lead Mentors, tutors and senior ITE leaders have given advice on the background issue and guidance on introducing the KQ to all mentors. As part of this study, in collaboration with partnership teacher educator colleagues (PGCE Lead Mentors and tutors), an agreed version of the KQ and associated questions has been produced. Science student teachers, mentors and a tutor in my context have been given the opportunity to voice their opinions about using the

KQ tool. Findings from my study will be shared in an ITE partnership meeting in autumn 2020.

3.4 Research instruments - methods and their limitations

3.4.1 Data collection methods

Table 3 shows the data collection methods used to answer the research questions.

Research Question	Data collection methods
1. In what ways is use of the KQ framework perceived by Lead Mentors, tutors and student teachers to be effective as a tool in facilitating beginning teacher learning in the areas of: a. Lesson planning b. Lesson observation analysis and feedback c. Reflection	Semi-structured interviews with Lead Mentors, tutor and student teachers (November 2019). Lesson plans, formal observation analysis and feedback forms and student reflection (part of science student teacher critical portfolios) analysed for evidence of the use of the KQ for the second action step (March 2020). A planned questionnaire to all mentors and student teachers and observation of mentors using the KQ and giving feedback was not undertaken, due to Covid-19.

2. In what ways is use of the KQ framework perceived to be a challenge?	As above.

Table 3: Research questions and data collection methods

3.4.2 Semi-structured interviews

This qualitative research study is shaped by my interpretivist view point (Cohen et al., 2018; Thomas, 2009) as I am interested in understanding the participants as people and the way they think and form ideas about the development of teacher knowledge so that I can listen to their voices and come to an informed understanding. I am also an active participant in my research, as it is based in my context (it forms part of my practice) so that I can understand it as an interested, insider researcher who interacts with the participants (Thomas, 2009). Moreover, from an ontological perspective, although I am gathering mentor and tutor perspectives on developing beginning teacher learning, ultimately it is not these teacher educators who do the learning it is the student teachers; students are active in this process and it is critical to gather their perspective.

Semi-structured interviews took place, after the first action step (November 2019) with two Lead mentors, one tutor and ten science student teachers. Table 4 shows the interviewees and interview times.

Interviewees	Interview time (minutes)
Lead Mentor 1	60
Lead Mentor 2	50
Tutor	60
Science student teacher 1, 2, 3, 4 5, 6, 7, 8, 9, 10.	30 minutes each

Table 4: Interviewees and interview times

A semi-structured interview schedule (with fewer questions for the student teachers; Appendix C), was chosen rather than a structured interview as it allowed for an agenda of targeted questions, rather than an unstructured interview with no predetermined format, allowing the interviewee to set the agenda (Yin 2009, Cohen et al., 2018). Semi-structured interviews also allowed the ability to follow up on any points made whilst still allowing the possibility of "coding responses easily" (Thomas, 2009, p.162) in order to provide "explanations and causal inferences" (2009, p. 102).

The questions were sent out to participants beforehand so they could ensure they understood the questions before starting and to encourage them to give thoughtful responses. This was also done to ensure that the interview was completed within the specified time limit (an hour for the Lead Mentors and tutor and thirty minutes for each student teacher). However, a limitation is the possibility that they may have manufactured responses or given responses which they thought I wanted to hear (Cohen et al., 2018, Yin, 2009). Moreover, there may have been "inaccuracies due to poor recall, response bias, bias due to poorly articulated questions and answers" (2009, p.102). To ameliorate this, I reminded the participants that I

was not looking for a particular answer to any question, they could ask me to clarify any questions and they did not have to answer the questions or give an explanation for not answering; they were also sent summaries to check for accuracy.

The questions were piloted with a member of university staff (who is also a school mentor). Questions were checked if they were ambiguous, imprecise, prejudicial or made assumptions (Cohen et al., 2018, p.358). Following the pilot, a more accurate minimum time for the interview was given. Two further questions were added to probe for concrete examples (question seven and eleven, Appendix C). I also made an attempt to establish an initial rapport through talking about something "inconsequential to break the ice" (Thomas, 2009, p.161). I decided to explain that I would be trying to be objective to allow the participants to say what they wanted and that any enthusiastic nodding did not necessarily mean I agreed (2009), so as to try not to lead them. A further limitation is that this may not have worked.

To ensure the focused interview was friendly and non-threatening (Yin, 2009, p.107), I tried to use a warm tone of voice, to nod and smile and met face to face, rather than conducting the interview over the phone. However, it can be difficult not to lead through use of positive body language, as discussed above. Asking semi-structured questions requires that the interviewer asks the questions "in an unbiased manner" and uses active listening skills (Cohen et al., 2018; Yin, 2009, p.106); as a novice researcher, I am still developing these skills. To ensure the accuracy of my data, summary notes of the interviews were sent to the participants to check for accuracy (they were also given the chance to delete or add anything further).

Table 5 shows how the interview questions were specifically designed to address the research questions.

Question (Question not put to students, QNPS)	**Purpose**	**Matching Research question one and two**
1 2 (QNPS)	Gather background information. Settler questions; easy to answer and non-threatening	✖
3 (QNPS)	Gather information on previous practice to compare using the KQ.	✓
4 (QNPS)	Ascertain mentor and tutor understanding of the concept behind the KQ to gain an indication of the ease of using the tool.	✓
5	Gather perceptions of the tool's effectiveness.	✓
6	Identify advantages and disadvantages.	✓
7 (QNPS)	Probe for concrete examples.	✓

8 (QNPS)	Gather perceptions of the influence on mentoring practice.	✓
9	Identify perceptions how the tool is less effective.	Research question two
10	Ascertain if previously identified challenges remain	✓
11 (QNPS)	Probe the effectiveness of using the tool.	✓
12	Probe how the tool should be used.	✓
13	Opportunity to add anything further.	

Table 5: How the interview questions are related to the research questions

Participants were given six weeks to trial the KQ's use. Interviews were held at a convenient time and place to the interviewees (in empty classrooms, to avoid disturbance). The interviewees were reminded that the interview would be audio recorded unless they had any objection, and of their right to withdraw permission at any point during the interview, without giving an explanation. (As a novice researcher, I had practised making notes during the pilot, in case participants would not consent to be recorded, Thomas, 2009).

My direct involvement in the interviews meant that I was able to reach a 100% response rate to my questions, compared to an on-line survey (Wilkinson & Birmingham, 2003, p.63). I

was also able to ask follow-up questions to check my understanding or to probe for additional meaning (Thomas, 2009). However, there are disadvantages to holding interviews. Interviews are time consuming and interviewing is a skill (2003; Thomas, 2009), that as a novice researcher I may lack at this stage. To some extent this was ameliorated by practising during the pilot. Nevertheless, a limitation of this study is that a more experienced researcher may have achieved different results (2003; Cohen et al., 2018; 2009).

To evaluate, I wanted to get an initial in-depth view of using the KQ through the semi-structured interviews and then I intended to get a wider view by questionnaire to all mentors, tutors and student teachers on the programme. In line with Brown & McIntyre's (1993) perspective on classroom research, to gain a true understanding and to make sense of the mentors' use the KQ tool, I also intended to observe mentors using it. Although asking to observe the mentors using the KQ might mean they do so simply on that basis, discussing how useful they found it could further illuminate the tools' effectiveness. The questionnaire and observation were not undertaken, due to Covid-19, instead data was collected from critical portfolios.

3.4.3 Critical portfolios

Student teachers on the PGCE produce critical portfolios. These are submitted at the end of the first placement and marked as an assignment. As school placement was terminated, data collection from observations and a questionnaire had to be abandoned. The portfolios provided a form of data, giving some evidence of the use of the KQ by science mentors and students in the areas of lesson planning, lesson observation analysis and feedback and reflection, informing both research questions.

Six science teacher critical portfolios, from those who gave their consent, were analysed; two from each science discipline.

Key data contained in each portfolio are:

- two formal lesson observation analysis and feedback reports from science mentors (including the lesson observation focus);
- lesson plans (for the observed lessons);
- post-observation student reflection (the students were tasked to use the KQ to develop their critical reflective skills);
- details of Lesson Study activity (the students were tasked to use the KQ to reflect on their findings).

3.5 Methods of data analysis

Summary notes were made of the interview data (Appendix D) in the order the participants were interviewed, to take advantage of the time available between each interview: Lead Mentor 1, tutor, Lead Mentor 2, student teachers. Costly or time-consuming transcription were not undertaken, rather (following supervisory advice) summaries were made. Summaries from Welsh medium interviews (seven of the thirteen interviews) were translated into English. Data from interviews were analysed in the same order as the summary notes (to keep track and to compare data, as part of constant comparison, Cohen et al., 2018).

The interview summary notes have been closely read and systematically coded (Coffey & Atkinson, 1996) to link together different, meaningful data to interpret it in order to come to conclusions. (Note omissions of a particular coded item may not actually indicate absence of knowledge, Barnett & Hodson, 2000).

Six critical portfolios, including student teacher planning, mentor lesson observation analysis and feedback forms and post-observation student reflection were then also read and systematically coded. (Appendix E; see Appendix F for a copy of the observation and reflection proforma). Science mentors' and student teachers' agreed foci for formal lesson observation (written in formal observation reports) were also analysed for any link to the KQ and the wording of the Teaching Standards (Welsh Government, 2019a; Appendix G).

I used deductive thematic analysis (Cohen et al., 2018) to make sense of the data, using codes from the literature 'assumed to be true' (Fazio & Melville, 2008, p.89). In accord with Fazio & Melville's (2008, p.197) methods (used to analyse data from science teachers' action research) "first level coding methods used labels, tags and categories to label units of data". Codes arose from knowledge quartet terms (Rowland et al., 2005, p. 265- 266 "Foundation", "Transformation", "Connection" and "Contingency") and the codes used to identify the different teacher knowledge in the original work by Rowland et al. (2005) and developed by Weston et al., 2013 (table 1) because of their empirical validity (they have been used by other teacher educators (2005; Rowland & Turner, 2007). As part of grounded theory and as an interpretive researcher, I used the constant comparative method (Thomas, 2009), going through my data several times comparing elements or phrases related to the KQ terms, definitions of the different categories of knowledge (Rowland et al,'s, 2005; Weston et al., 2013) and my two research questions, ensuring the number of un-coded statements was low

(Barnett & Hodson, 2000). (Emergent categories included ‘time’ and ‘misconception’.) These codes were then “clustered” (2000, p.197) to form “themes and patterns” to allow for interpretation. Themes and sub-themes were identified, in order to ensure that all issues arising from the data were made visible (Cohen et al., 2018; Thomas, 2009). Themes were used to ensure meaning is constructed by the participants’ answers to the interview questions (Thomas, 2009, p. 198) and the analysis of the students’ critical portfolios. The themes were mapped (2009) (Appendix H) to demonstrate the interconnections between them (Braun & Clarke, 2006). Figure 2 gives an example of a theme, sub-themes, code and an initial response to an interview question.

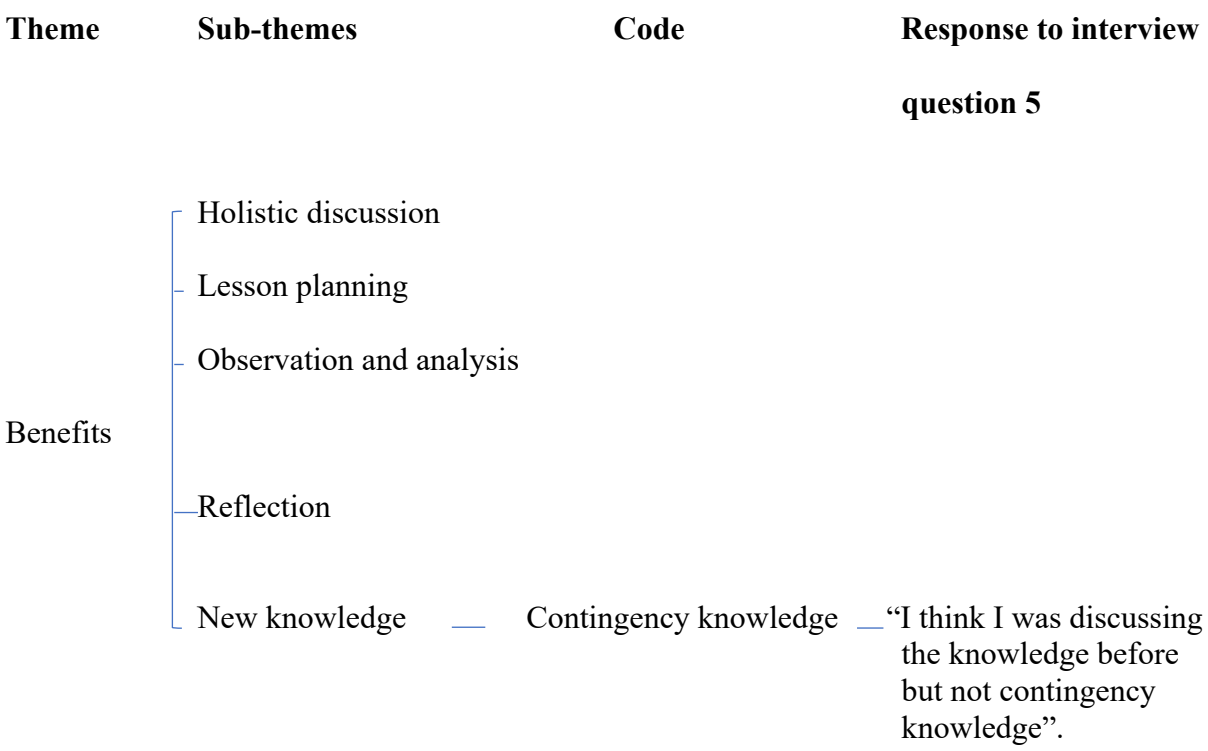

Figure 2: Example of a theme, sub-themes and code

Findings from the interviews were triangulated (Cohen et al., 2018; Thomas, 2008) with data from the critical portfolios, to “compare and contrast findings” (Elliott 1991, p.82). Initial

findings from the semi-structured interviews informed the amended plan and further steps (3.3.2).

As my research study was affected by Covid-19 (data collection from observations and questionnaires were not carried out) and, with due consideration of the influence of researcher bias (Denscombe, 2010; 4.3.1), any findings are subject to the proviso that further data collection may have illuminated different conclusions.

3.6 Ethical issues

Before undertaking this study, formal permission from ITE leaders in my context was sought and gained in writing. Permission to undertake this study was also given by the Central University Research Ethics committee, Oxford University and follow the British Educational Research Association (BERA, 2018) guidance for educational research. No incentives were offered to participants and the research was not sponsored.

An information document was produced to explain the study in detail and each participants' voluntary informed consent was obtained in writing (Denscombe, 2010) before participating in the study. The consent form also notified participants how their contributions would be used, including in any future publications. Consideration was given that the mentor and tutor participants might feel obliged to take part in my research study, as we have worked together closely in the past. To overcome this issue, it was explained to the participants that they did not have to take part and could stop taking part at any point in the study, without giving a reason and that to ensure the ethical nature of my study there would be no consequences to

such action, other than any data they had given would be permanently deleted (Denscombe, 2010; BERA, 2018). This was especially important with my science student teachers, who, because of the power differential (Tang & Chow, 2007), could feel obliged to take part in the study and to share their coursework for the purposes of the study. (At least one student did feel confident enough to share that they had not used the KQ). To help mitigate this, students were also reminded that they did not have to share their critical portfolio for the purpose of this study and their consent was gathered before any analysis was conducted. There is also a risk that the students, mentor and tutor colleagues would try to give me answers they thought I wanted to hear. To go some way to mitigate this, participants were interviewed separately; this also prevented some dominating the interview and allowed quieter participants to have their say. However, as action research is about interpreting perspectives to come to an understanding, rather than a search for truth (Denscombe, 2010; Cohen et al., 2018), consideration of the power differential (Tang & Chow, 2007) and close working relationship will be taken into account when coming to final conclusions and implications for practice.

On presenting my study and asking for mentors, tutors and students' participation, I left the room so that the they did not feel obliged to fill in consent forms; any filled in forms were then collected at the end of the day by a colleague and given to me the following day. Permission was also sought to audio record the interviews. Again, if this was not given, or withdrawn, then permission was sought to take notes.

As the number of participants is low it was important to ensure that the participants were not made to feel that they must take part or remain part of the project. Mentors and students are busy people and might feel pressure because of time constraints to fit in an interview, so it was important to share timing for the possible interviews at the start of the project and to give

the widest window of opportunity to interview them without making them feel pressurised to take part during their busy periods.

As the project proceeded, any instances when Lead Mentors or students discussed colleagues, participants were asked if they wished me to leave out or delete this from the data. Summary notes were sent out to each participant for verification (this was especially important for those I had translated from English to ensure the accuracy of my translation) and participants were given a further opportunity to check the accuracy and/or to withdraw data.

The participants are known to me. Participants' right to privacy has been respected at all times (Denscombe, 2010). All responses have been anonymised and individuals are referred as, for example, Lead Mentor 1 (LM1), tutor, student teacher 1 (ST1) etc. and personal pronouns avoided (2010). Personal data were given a code only known to me to ensure anonymity when writing up or discussing this study. The research data was stored confidentially on my password protected computer within a separate confidential folder and within a locked cabinet for paper documents. In accordance with the University of Oxford's policy on the Management of Supporting Research outputs (2019), all research data and records will be stored for a minimum retention period of three years after publication or public release of the work of the research, and then destroyed. Although it is not envisaged that participants may feel upset by the research, they were given both my and my supervisor's contact details so should they wish to make a complaint they could do so or make contact if they had any further questions.

3.7 Summary

This section has discussed the methodology, the nature of the intervention undertaken (trialling the use of the KQ in my context) and the design of the action research study, including ethical considerations, choice of methods (semi-structured interviews, critical portfolio analysis), limitations of the methods employed and methods of data analysis.

Section 4: Findings and discussion

Data from summary responses to semi-structured interviews (Appendix D), analysis of observation and feedback forms, students' planning and reflection (from students' critical portfolios; Appendix E and G), my knowledge of the context and field notes, together with findings from the Literature Review are used to answer my research questions. Findings from the more substantial first action research cycle and more tentative findings from the second cycle (affected by Covid-19) are presented against each research question. A final section provides a discussion of limitations and a summary.

4.1 Research question one

This section will address the first research question (below) discussing each area in turn:

In what ways is use of the KQ framework perceived by Lead Mentors, tutors and student teachers to be effective as a tool in facilitating beginning teacher learning in the areas of a. lesson planning, b. lesson observation analysis and feedback and c. reflection.

4.1.1 Lesson planning

This section presents the findings from the two action research cycles in turn and outlines two claims. Firstly, the KQ tool is perceived to be a helpful guide to structure lesson planning, by categorising and drawing attention to underlying teacher knowledge. Secondly, using the KQ is perceived, by student teachers, to be useful in supporting them to understand how judgements are made about the efficacy of their lessons; this helps inform their planning.

a. *First cycle findings*

The reconnaissance phase informally established (through conversation) that the KQ tool was new to my context and that trialling it was perceived to be worthwhile.

With regards to my claims (above), firstly, the LMs, university tutor and science student teachers seem to perceive the KQ framework as a "pretty simple" (LM2), useful aide-memoire to help mentors guide beginning teacher planning, helping students to structure planning and consider underlying teacher knowledge. The tutor said:

> For the school mentor, you have a structure to follow and consciously think about. It gives a clear, coherent, sensible structure to follow for planning which makes sense - decomplicates the process.

Some student teachers (ST1, ST4, ST5) also considered it "categorises aspects of teaching for planning" and LM2 thought it was useful to students to "identify building blocks of their practice". Typical student responses are:

> It gives a structure to think about planning and evaluate my teaching; it helps me to consider how pupils learn and to consider learning across the curriculum.

LM1 thought: "It does remind students that fundamental subject knowledge is required for planning".

Secondly, some science student teachers perceived the KQ to be useful because mentors can use it to evaluate their choice of planned pedagogical strategies and that this helps inform their further planning. A typical student response is:

> Good to use to see if your lesson was successful and to know what people are assessing and so useful for planning.

This may intimate that some science mentors were using the KQ, but from second cycle research findings, this is not clear; the lesson plans in the critical portfolios were not annotated with mentor feedback.

b. Second cycle findings

These findings tentatively outline the outcome of the extra KQ training and guidance offered to the science student teachers. (Note: as mentioned above, there is very little evidence, in the portfolios, of mentors using the KQ to structure feedback on lesson planning.) There was some evidence (as with the first cycle) of science student teachers being aware of underlying teacher knowledge and using this to inform their planning. For example, in the critical portfolios, some student teachers described improving their foundation knowledge to support their planning (Rowland et al., 2005). A typical example is:

> I used all this research to improve my foundation knowledge before I even started to plan the lesson.

Science students' post-observation reflection (Appendix E), in the critical portfolios, indicate that they are aware of using their transformation knowledge in order to plan to support pupil learning (Rowland et al., 2005). A typical response from a student teacher is:

> I transform my knowledge into a form the learner can understand by planning and forming resources to simplify my knowledge into a form the learners understand.

There is also some evidence of attempts to consider connection knowledge when planning to help pupils to link learning within and between lessons and subjects, resonating with Wales's interconnected new curriculum (Welsh Government, 2019b). A typical example is:

> I planned a series of activities that built up to the final task of drawing a graph and showed the learners how these connected together to help them with their final task.

4.1.2 Lesson observation analysis and feedback

This section outlines three key claims. The first two arise from the first action research cycle and the third claim comes from the second cycle.

a. First cycle findings

During the reconnaissance phase, my reading (of Feeney, 2007; John 2006; Estyn, 2018; Chapman, 2015) led to my decision to produce, in partnership, a collaboratively agreed version of the KQ for the PGCE programme, with associated questions to support mentor observation dialogue, discussion and feedback.

My first claim, in the area of observation and feedback, is that there are five key benefits respondents perceived in using the KQ. It then goes on to claim that participants perceived using the KQ does need some training, but familiarity and use over time also seems to remove some of these difficulties. Finally, the section claims that, over time, the areas chosen to focus on for observation and feedback change and develop.

The first key benefit was expressed by the tutor, who considered the KQ was useful for their professional development, as it supported them when observing student teachers outside their specialism and phase (Rowland & Turner, 2007) to give useful feedback:

> It has helped me to develop my practice as a tutor. When I am supporting students outside my specialism, I can give them useful feedback.

This was supported by LM1 who also considered the KQ might be helpful to think of ways of discussing student teachers' development following lesson observation, particularly in the area of transformation knowledge:

> It raises awareness of what you could ask or discuss to support student teachers' development. It does make you think about how they will develop their transformation knowledge.

Secondly, LM1 considered the associated questions, produced by mentors and tutors to accompany the KQ framework, to support a coaching style (Estyn, 2018; Joyce & Showers, 1988) appropriate for lesson observation analysis and feedback.

Thirdly, LM2 also thought it was important for mentors to use the KQ from the start to promote dialogue and discussion (Feeney, 2007; Mutton et al., 2011; Tang & Chow, 2006):

> Discussing this with the student teachers early on in their development is integral for the dialogue.

Fourthly, although useful for mentors there was a LM perception that the KQ tool may be more useful for student teachers. LM1 said: "It is more useful for the students to analyse their

practice" and to move away from mentors telling beginning teachers their own perceptions of the lesson. This resonates with current thinking (Estyn, 2018) in my context regarding mentoring, as explained by LM1:

> Mentoring is a key skill and if they just tell the students things, the students will only listen to the first three words. The students need to process things and start working on what should happen next. Pupil outcomes are dependent on teacher knowledge so you need to put an emphasis on the link between their knowledge and pupils' learning so that they can take ownership of this.

Fifthly, many of the respondents could see the benefits of using the KQ in that it explicitly identifies and breaks down key aspects of teacher knowledge, allowing the mentor and beginning teacher to focus specifically on different types of knowledge, to break down the task of what needs to be learnt into more manageable parts and highlight connections.

For example, some science students thought it was helpful to consider one area of teacher knowledge at a time during lesson observation to help their development. Explicitly delineating the different knowledge bases were perceived to be important by the tutor in that it allowed them to be considered in the following order, also intimating that the different knowledge areas are connected (Rowland, 2013):

> Foundation, Transformation, Connection and Contingency and then bounce around and have the pupils in the middle.

There was also some intimation from the tutor that the KQ was illuminating new aspects of teacher knowledge during lesson observation: "I think I was discussing the knowledge before but not contingency knowledge". There was disagreement whether contingency knowledge is a marker of a more able student teacher, but LM2 thought more classroom experience

supports the development of this knowledge. LM1 and some science student teachers thought it was useful to be aware that foundation knowledge (including accurate subject knowledge, Gess-Newsome & Lederman, 1999) is required for teaching. Confidence in their foundation knowledge is also perceived to help beginning teachers to employ their knowledge (Rowland, n.d.).

There was a perception that the KQ was a useful tool for giving feedback in breaking knowledge areas down but that its use may need to be differentiated. For example more able student teachers could have more holistic discussions of teacher knowledge and less experienced or weaker ones focus on one area. A typical response is:

> Depends on the context and the individual, sometimes it will be holistic and sometimes more focused.

There was some consideration that a focus on some teacher knowledge may need to come later on but there was also uncertainty. LMI asked: “Is it appropriate for the whole journey, should some aspects come later on?”

The second claim in this section is that, although there is a need for training, using the tool gets easier over time. LM1 says “the more you use it the easier it gets”. LM1 also discusses how analysing teachers’ practice is a skill and although having an analytical tool is helpful, guidance is required for its effective use with mentors:

> Experienced staff observe each other and get nothing out of it as they don’t know how to analyse their practice.

During their introductory session to the KQ, mentors thought an area they needed support in particular was beginning teachers' transformation knowledge, as this was, for them, the most difficult to define and, presumably, to comprehend and develop. However, over the time of using the KQ, LM1 and the tutor developed their understanding of transformation knowledge, intimating they now found these aspects easier to understand, possibly as they became familiar with the tool. Similarly, student teachers developed their understanding of foundation knowledge, over time.

b. Second cycle findings

The third claim is that, over time, the areas chosen to focus on for observation and feedback change and develop. The first observation foci were varied but for their second formal observation (Appendix G), many science student teachers were asked to focus on aspects of assessment (part of transformation knowledge and PCK, Rowland et al., 2005). (Note the collaboratively amended version of the KQ produced as part of this study, unlike the original, Rowland et al., 2005, refers to assessment under transformation knowledge; Appendix A.)

4.1.3. Reflection

This section outlines five claims; three from the first action research cycle and two from the second cycle. Firstly, that respondents found the KQ a useful tool to support beginning teacher reflection (Rowland, 2013). Secondly, one teacher educator (the tutor) perceived that the KQ may be a useful tool to facilitate teacher educators' learning. Thirdly, although useful, science student teachers perceived that they needed more guidance on how to reflect and

requested exemplars. Fourthly, evidence from the portfolios seemed to show that the beginning teachers were able, using the KQ, to structure post-observation reflection, reflecting on a wide range of issues. Finally, fifthly, using the KQ to analyse and reflect on collaborative planning exercises may support beginning teachers to appreciate aspects of mentors' underlying teacher knowledge.

a. First cycle findings

Findings from the first cycle include, firstly, the respondents perceived that the KQ was useful in a number of ways to support post-observation reflection. (The reconnaissance phase established the KQ can be used to support student teacher reflection, Rowland, 2013). For example, the tutor perceived that the KQ offered a "framework to engage discussion and reflection". LM2 agreed and perceived further that "It helps students to conceptualise and rationalise what worked and did not work". A science student teacher (ST5) thought the KQ helped improve the quality of their reflection and that "It has helped me to complete better reflections".

Secondly, as well as providing a useful tool for supporting student teacher reflection, one tutor wanted to explore how the KQ could be used to support teacher educator reflective practice when they said:

> It would be useful if we could use it for our practice. Could we use this to analyse our sessions?

Thirdly, nearly all the science student teachers requested an exemplar and help in using the KQ to reflect for their first assessment (this was provided). A typical response shows the student recognising the KQs potential but needing more help to use it more effectively when they said:

> It helps me to reflect on lessons and evaluate learning, but I need more help to understand it.

Over time, my study became more focused on using the KQ tool to facilitate beginning teacher reflection, in order to help my science student teachers to take ownership of their own development (as part of inquiry-led learning, EWC, 2019; Furlong, 2015) and to write about this reflectively in their first assessment (Boud, 2007; Nicol, 2007); as the students became more focused on critical reflection, so they asked for more help.

b. Second cycle findings

My fourth claim, in the area of reflection, is that there is some evidence in the science student teachers' critical portfolios to show beginning teachers using the KQ to structure reflection on a wide range of issues, including responding to key curriculum requirements. For example, there was evidence in their reflective writing that they tied underlying learning theory to their developing transformation knowledge, perceiving themselves as a more knowledgeable other, choosing valid pedagogical strategies (a marker of transformation knowledge, Rowland et al., 2005) known to support the pupils through their zone of proximal development. The science student teachers also reflected on how they tried to support pupils to improve their skills and understanding, trying to help their learners to overcome misconceptions during science lessons, showing they are trying to respond to curriculum requirements (Welsh Government, 2019b).

Finally, fifthly, using the KQ to structure analysis and reflection on a Lesson Study (Cajkler & Wood, 2015) exercise, as part of their portfolio, seems to support some student teachers to gain insight into their mentor's planning:

> I saw during Lesson Study how my mentor planned lessons. I learnt how she connected lessons to other topics and subjects.

Such collaborative planning exercises (John, 2006), supported by the use of the KQ, may make it easier for novices to reflect and appreciate the importance of developing and using underlying teacher knowledge, such as connection knowledge when planning (Welsh Government, 2019b).

4.2 Second research question

This section addresses the second research question: In what ways is use of the KQ perceived to be a challenge? Three claims are made. Firstly that, as the tool is new to my context, a key challenge is that more training and guidance is required to fully understand it and get the most out of using it. Secondly, another key challenge is that setting student teacher targets based on the Teaching Standards (Welsh Government, 2019b) and assessment against the Standards is deep-rooted in my context and there may be a need to make it clear how using the KQ fits in with accountability measures. The third claim is that since ITE in my context has undergone much reform (EWC, 2019) in the past year and my study was cut short (due to Covid-19), a key challenge is that more time is required in order to embed its use and for mentors to evaluate its effectiveness.

a. First cycle findings

Findings from the first cycle give evidence for the first claim that there is a need for further training and guidance (education) to fully understand the KQ and maximise its use, as the associated terms and the concept of teacher knowledge are new to nearly all teacher

educators in my context. During the reconnaissance phase and discussions with tutors and mentors, only a mathematics university tutor had heard of it but had not used it. LM1 said previously: “I did not discuss teacher knowledge”. The tutor felt that they had needed further guidance in order to fully understand the KQ and thought that some mentors would need more help to get the most out of the tool to facilitate beginning teachers’ learning:

> It is a model, so I needed some guidance from you to get it. I think some mentors need more help to get the most out of it. If their analytical skills are not as well developed, they may not get as much out of it. I would not have got as much out of it nine years ago.

Similarly (4.1.3), student teachers requested more help to use the KQ to critically reflect.

Mentors may need more help to analyse transformation knowledge and teaching decisions (Childs & McNicholl, 2015; Brown & McIntyre, 1993), as explained by LM1:

> What makes transformation knowledge difficult is that you have to analyse it; some teaching is like muscle memory you may not know why you are doing it.

This resonates with Childs & McNicholl’s (2015, p.120) findings that teachers do not always “articulate the why part of practice”, rather they focus on describing strategies and tasks.

Using the KQ seems to require careful introduction, particularly as LM1 thought the KQ tool might give rise to a misconception:

> It is teacher focused, as it is their knowledge. Perhaps the focus on pupils could be lost. It is called teacher knowledge, so it looks like the focus is on the teacher and they do need to consider the pupils’ learning as part of transformation knowledge.

The tutor seemed to agree that beginning teachers' attention should be drawn to the pupils' learning (Estyn, 2018) when discussing using the KQ: "have the pupils in the middle".

Although there is some evidence (4.1.2) that the student teachers in this study are focused on pupils' learning (Burn et al., 2003), as explained by Burn et al. (2003), they may be less knowledgeable about the actions they should take to meet those needs. The request for help, by one science student teacher, with challenging pupils indicates that aspects of contingent incidents preoccupy some beginning teachers (Maynard & Furlong, 1995).

With regards to the second claim that assessment against the Teaching Standards is deep-rooted in my context, rather than using the KQ to support student teachers towards meeting the Standards, the LMs and tutor said they used the ITE centre's new formal lesson observation and feedback form (Pedagogy Assessment form; Appendix F) to discuss student teachers' developing practice during post-lesson observation. For example, LM1 said: "I use the Pedagogy Assessment form".

The two LMs and university tutor perceived there had been a recent change to mentoring practice in my context, explaining previously the wording of the Teaching Standards (Welsh Assembly Government, 2009) "were the driving force" (LM2) behind mentoring practice. This is related to accountability (Estyn, 2020; Burn et al., 2015) and the need to collect data to show beginning teacher progression over time. Although there was also a feeling from the tutor that analysing practice against the Standards was "not fair" and that student teachers could "hide behind the Standards" rather than engaging directly with what they needed to improve, there was no discussion of teacher knowledge as a concept and knowledge was not

discussed unless it was mentioned in the Standards (differently to Ben-Peretz', 2011 findings). The tutor explained:

> We did not discuss teacher knowledge as an idea but rather discussed the wording of the Standards. So if the Standards said something about subject knowledge or knowledge of assessment strategies that is what we discussed.

LM1 suggests, the KQ could be used for more holistic discussions and formal post-observations focus more narrowly on developing teacher knowledge towards meeting the Standards, however, this may need to be made clearer to mentors:

> The KQ is useful for day to day discussion of holistic development. The pedagogy assessment form for formal observations is more useful with its narrow focus. You can use the two to build up a picture of their whole development.

Moreover, holistic discussions can be time consuming. This leads to the third claim that using the KQ takes more time. As explained by LM2, a significant challenge to using the KQ is time (Coe et al., 2014; Brown & McIntyre, 1993):

> Time to use it – so much better with more time. I might try to do it earlier on. We don't have enough time.

Time is required to introduce the KQ, to help mentors, tutors and student teachers to become familiar with it as a tool to support planning, lesson observation analysis and feedback and reflection and to try it out. Although using it over time does seem to make it easier (4.1.2), as explained by LM1: "to begin with I thought it was difficult but now I think it's ok".

Evidence suggests that using the KQ for one academic term does not seem to be sufficient to embed its use with student teachers, mentors and tutors. Although all science student teachers had used it by February 2020 in order to complete their assignments, in late November one science student teacher had not used the KQ and other science students felt they could it use it more often: “Not really used it. I need to use it more”. The tutor and LM1 thought in November they had not had enough time to conclude on its usefulness: “too early to tell if the KQ is helpful for the students’ development”. Moreover, LM 2 considered “in the grand scheme of things” other professional learning had been more impactful, intimating that there were several initiatives competing to develop mentoring in my ITE centre during this period:

> What was more pivotal for me was Philippa Cordingley’s session on questioning and listening.

A lack of time and several new developments in my context, vying for mentors’ attention, may go some way to explain why LM2 said they were using the KQ “subtly not overtly”.

b. Second cycle findings

There is some evidence from the critical portfolio analysis to support the first claim (a need for more training and guidance), as contingency knowledge seems not to be well understood by some student teachers; this may limit their ability to analyse and reflect on their teaching and they may benefit from further guidance on this. Some student teachers perceived contingency knowledge as just a way of dealing when things go wrong, perceiving it, as one science student teacher put it, in their portfolio, as an ability to “think on the fly”. Contingency knowledge is more than possessed knowledge it involves action and it is more than just thinking of a way out of or a way back from an incident, it is about taking deliberate

action which supports learning (Rowland, 2013). Moreover, there was also no mention in the critical portfolios of student teachers using unexpected incidents or questions in the classroom during observations to further pupils' understanding or progress their learning. Although this omission does not necessarily mean an absence (Barnett & Hodson, 2000), it may hint that, during training and in documentation, contingency teacher knowledge may need to be more explicitly tied to further action taken by student teachers to support pupils' learning.

With regards to my second claim (that using the KQ is challenging because many mentors set student teacher targets based on the Teaching Standards and assessment against these Standards is deep-rooted in my context), although findings from the first cycle suggest the mentors and tutor perceive that the Teaching Standards are no longer driving mentoring practice, in the second cycle an analysis of the observation and feedback forms, submitted as part of science students' critical portfolio, showed that many foci were directly related to the new Standards (Appendix G; Welsh Government, 2019a) or the wording of the former Standards (Welsh Assembly Government, 2009). Mentors, in my context must make judgements on the progress of student teachers against the Teaching Standards (Welsh Government, 2019a) at the end of each placement, as part of accountability measures (Estyn, 2020); mentors' use of the KQ is not mandatory. Accountability measures may encourage some mentors to focus on the Standards, rather than considering "what is desired and developmentally reasonable" (Schneider & Plasman, 2011, p.532). For example, there was no evidence of mentors annotating lesson plans. Although this does not mean mentors are not analysing and giving feedback on lesson plans, there is no written evidence. There was also very little evidence (from the portfolios) of science mentors' use of the KQ to structure discussions and feedback around developing teacher knowledge. This may indicate mentors

miss opportunities to help their student teachers, as adult learners (Burn et al, 2015; Loughran, 2000), to focus on improving their underlying teacher knowledge as a step towards meeting the Standards. It may be helpful to make it clear how using the KQ fits in with accountability measures.

4.3 Limitations and Summary

4.3.1 Limitations

A significant limitation of this study is that it was cut short; with more time different findings may emerge. For example, some mentors only work with students during the second placement and, as this was terminated (due to Covid-19), they had hardly any time to engage with the tool. A related key limitation of the study is that, as the study was cut short, not all PGCE mentors and students were questioned about their perceptions of using the KQ; I have not collected any quantitative data that may have illuminated the extent of participants' perceptions (Denscombe, 2010). Moreover, as my second research cycle was affected by Covid-19, I did not formally observe mentors using the tool and giving feedback to gain an insight into how the tool is used in context, although asking to observe them using the tool may alter their behaviour or make them engage with its use in a way they would not have done otherwise (2010).

Secondly, there is also the possibility that science student teachers felt obliged to engage with the tool because of my involvement in the intervention and the power differential between us (Tang & Chow, 2007; Denscombe, 2010). An outsider researcher may have had different findings (2010). As an insider researcher (Cohen et al., 2018), all my participants may have

felt obliged to be positive about the KQ because of my close working relationship with them. Moreover, as discussed previously (3.4), a more experienced researcher (Thomas, 2009) may also have elicited different responses from the participants during the semi-structured interviews.

Thirdly, as an interpretivist (Denscombe, 2010), I am providing explanations for my findings which another researcher may disagree with; there is 'uncertainty within interpretivists' explanations' (2010, p.123). My personal biases may mean I have made assumptions or missed the significance of what participants were telling me (2010; Thomas, 2009). For example, I have assumed I understand my ITE context well, but this may not necessarily be correct, especially as there have been so many changes to ITE during the period of this study. An attempt was made (3.3.3) to mitigate this by interviewing participants most heavily involved and leading mentoring in my context, however, as outlined above, an outsider researcher may have found things differently (2010; Cohen et al, 2018).

4.3.2 Summary

In summary, with respect to my first research question, findings from the first action research cycle and tentative findings from the more modest second cycle indicate using the KQ tool is perceived to be effective in facilitating beginning teacher learning in several ways, in the areas of planning, observation and feedback and reflection. However, there are also challenges to its use. More guidance, training and time may support its use.

The next section will outline the conclusion and implications for practice.

Section 5: Conclusion and implications

5.1 Conclusion

With respect to my two research questions, Section 4 identifies several ways in which using the KQ, as a new tool in my context, is perceived to be effective in facilitating beginning teacher learning in the areas of lesson planning, reflection, lesson observation and feedback, as well as challenges. In conclusion, use of the KQ tool is not yet embedded in my context. More time and education (training and guidance) are required to embed its use.

This small action research study has contributed to developing practice (including my own) that facilitates beginning teacher learning; the findings have value for my context. The findings are unlikely to be generalizable to other contexts and are tentative; the former due to my interpretivist stance (Denscombe, 2010) and the latter as my study was cut short, due to Covid-19.

The outcomes of this study may be of interest more widely, to other teacher educators who may wish to research use of the KQ. Moreover, as the student teachers who took part in this study have had less experience in the classroom than normal (due to Covid-19), before starting work as newly qualified teachers (NQTs), my findings (especially related to contingency knowledge development) may be of interest to those working with NQTs, including Wales's educational consortia.

5.2 Implications

5.2.1 Implications for mentoring and beginning teacher learning

Drawing on my findings and professional knowledge of the context, there are four key implications for mentoring and beginning teacher learning from this study. The first key implication is that a series of sessions, sustained over the academic year (Cordingley et al., 2015), could help both student teachers and teacher educators to make the most of professional learning and help embed use of the tool. Undertaken in close partnership with schools (Chapman, 2015; Stoll et al., 2006; Lave & Wenger, 1991) and underpinned by positive partnership relationships (Harris, 2010), collaboratively produced sessions could build on findings identified from this study. Mentors could be encouraged to contribute to the student teacher sessions, for example, sharing their experiences and modelling discussions using the KQ, highlighting the need to focus on pupil outcomes, making the KQ more educative. (Exemplar student teacher reflection and mentor analysis of lesson plans using the KQ could also be shared and analysed to support learning during these sessions.)

It may also be useful to share how the KQ is perceived to categorise teacher knowledge into manageable parts (Rowland et al., 2005), offering a structure that informs student teachers' understanding of the lesson planning process, supporting reflection (Rowland, 2013), as well as giving students insight into how mentors judge the efficacy of student teachers' teaching. It may also be useful to share perceptions that focusing on one or two areas of the KQ can be developmental (complimenting teaching observation foci that change and develop over time) but remind mentors that this can be tailored to the specific learning needs of the beginning teacher. Exploring how connection knowledge (2005) resonates with the new highly connected

Welsh curriculum (Welsh Government, 2019b), may also prove worthwhile in ITE contexts in Wales.

Although further training is required, using the KQ is perceived to get easier over time. Since there is also some evidence from this study that contingency knowledge, as a new aspect of teacher knowledge for my context, is not well understood by student teachers and given stage model theory (Maynard & Furlong, 1995), it may be helpful to re-visit and focus on contingency knowledge in sessions later in the academic year, when student teachers have had more classroom experience.

The second key implication is that it is only in partnership (Chapman, 2015; Stoll et al., 2006), by working with colleagues and identifying (Kotter, 2012) mentor advocates from school who will lead and support change to practice, that use of the KQ tool by mentors will be embedded, over time, in my context. Lead Mentors could be encouraged to lead (2015) an exploration during mentor development of how using the KQ fits in with the ITE centre's vision for the mentoring role and the range of methods used to promote dialogue and feedback (Copland, 2009). As the collaboratively produced associated questions are perceived by Lead Mentors to be helpful, attention could be drawn to how their early use is perceived to promote dialogue and discussion (Estyn, 2018; Feeney, 2007; John, 2006). Short video clips of mentors using the KQ to promote dialogue and feedback to help student teachers towards the Teaching Standards could also be shared during mentor development.

Drawing on findings with respect to my second question, in the high accountability, high stakes environment of ITE (Burn et al., 2015; Welsh Government, 2017), observations may focus on the Teaching Standards, even when grading against these is removed. However, Teaching

Standards are important (Welsh Government, 2019a), so training and guidance in my context (and beyond) may need to carefully highlight how using the KQ fits in with supporting beginning teacher learning towards the Standards. A solution focused approach (Chapman, 2015) to the challenge may be helpful. It may also help to explore, in partnership, the extent to which teacher knowledge underlies the Teaching Standards. Mentors could be given an opportunity, during mentor development, to explore the Teaching Standards and underlying teacher knowledge, cross-referencing the KQ teacher knowledge categories to the Standards. The outcome of this exercise could be shared and explored with the student teachers.

During mentor development, it may also be helpful to emphasise how by engaging with the KQ, mentors are developing their own knowledge and learning, something they may discuss with their student teachers to support the concept of continuous professional learning in teacher education (Estyn, 2018; Burn et al., 2015). This may be supported by drawing on tutor interest identified in this study (Kotter, 2012) and exploring in partnership how using the KQ tool can be used to evaluate teacher educator practice (Author, 2020). This may not only support familiarity with the tool but help embed its use over time (Cordingley et al., 2015), providing a means of drawing together analysis and reflection across ITE in my context; many of our student teachers develop into partnership mentors. Mentors' perceptions of using the KQ to facilitate analysis and reflection on their own practice would be an interesting extension to this research study.

The third implication is that as there is a perception that the KQ is more suitable for holistic, time-consuming discussions (possibly making it less attractive to busy professionals) a realistic discussion of the time required for mentoring in my ITE partnership may prove helpful. Finally,

the fourth implication is that, as using the KQ is perceived to be most effective when student teachers engage with the tool and take ownership of it (supporting inquiry-led learning, EWC, 2019; Furlong, 2015), academic assessment requirements to use the tool, considered to drive such practice (Boud, 2007; Nicol, 2007) should be retained on the PGCE programme.

5.2.2 Implications for my learning as a teacher educator

Participation in this study has developed my skills as a teacher educator. By researching how change has been embedded in other ITE partnerships (Chapman, 2015; van Velsen & Timmermans, 2014) and leading an intervention designed to change and develop practice in my context, I have refined my leadership skills (Kotter, 2012) and gained an improved understanding of the benefits of collaboration and undertaking research with school and university partnership ITE colleagues (Mutton et al., 2018; Stoll et al., 2006). By undertaking this research, I have strengthened my research skills; I am also sharing my learning with colleagues and university students in my ITE centre. Listening to participants' views on developments to inform further action has given voice to my teacher educator colleagues at school, university and my science students on the PGCE programme. Taken together, this has supported my engagement with Government vision (EWC, 2019; Furlong, 2015) for reformed ITE in Wales to be both research-informed and involve close partnership collaboration.

5.2.3 Further research

As my study was affected by Covid-19, more time would allow data to be collected from observations (and discussions) of mentors' use of the KQ and questionnaires to be sent to all PGCE secondary mentors and students about their use of the KQ, so that I can report more definitively on how it facilitates beginning teacher learning; questioning student teachers more widely than my own group may also help mitigate any power differential (Tang & Chow, 2007) felt by any of my science student teachers.

Further research, into the use of the KQ more widely in my ITE centre (including with student teachers and mentors on our other ITE programmes), observing mentors using the tool, as well as researching its use in supporting collaborative learning methods (including Lesson Study), may be of interest to other teacher educators. An interesting addition to this study could also be ITE inspectorate perceptions of the KQ's effectiveness in facilitating beginning teacher learning and mentor development. (A visit by Estyn to my ITE centre during this study was cancelled, due to Covid-19).

5.3 Summary

Taking a solution-focused approach (Chapman, 2015), discussing in partnership, sharing and celebrating what works well, aiming to build on positive aspects of this study and using mentor advocates (Kotter, 2012) to lead mentor professional learning may embed use of the KQ to support beginning teacher learning in my context and more widely. Using a range of feedback methods (Copland, 2009), including use of the KQ, to stimulate discussion, analysis and reflection (Hagger et al., 2008; Estyn, 2018; Tang & Chow, 2006), seems apt to facilitate beginning teacher learning towards the Teaching Standards. However, use of the KQ may be

most powerful when beginning teachers, supported by a series of professional learning sessions (Cordingley et al., 2015) and assessment requirements (Boud, 2007; Nicol, 2007), take ownership of it, using it to facilitate the development of teacher knowledge and research skills (critical analysis and reflection) that underpin the beginning of career-long inquiry-led learning as a professional teacher.

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APPENDICES

Appendix A

Knowledge Quartet in course documentation (X, 2019, p 23): '*The following reflective instrument also has a set of questions; this time they are classified according to four different types of knowledge known as the* ***Knowledge Quartet*** *(Rowland et al. 2005)*.'

Foundation Knowledge	**Transformation knowledge (PCK)**
What did the teaching and learning in this lesson reveal about: • the teacher's subject knowledge; • their knowledge of the curriculum; • their beliefs about the nature of the subject; • their beliefs about teaching and learning; • their knowledge of the pupils?	Which teacher activities (demonstrations, practical work, instructional materials and assessment) did the teacher use to facilitate the pupils' learning? Why did they choose these methods? Was it clear to pupils what they were supposed to be doing, why they were doing it and what they would be learning? How did the teacher support the pupils to understand concepts? What helped the pupils to learn? (When did the pupils learn the most during the lesson?) How did the teacher respond to students' ideas?
Connection Knowledge How did the teacher make connections between activities during the lesson? How did the teacher ensure a logical sequence of activities? How did the teacher make connections with prior and future learning? How did the teacher link the learning objectives with the activities? How did the teacher link the activities to the curriculum?	**Contingency knowledge** How did the teacher respond to students' ideas? Were there instances of unplanned events occurring: e.g. a student asking an unexpected question, a lack of resources or something 'going wrong'? If so, what were they and what did they signify? How did the teacher respond/cope?

Appendix B

An example of a reflection, using the KQ, analysed and discussed during an extra session delivered to the science student teachers.

During this lesson I was very familiar with the background knowledge (foundation, Rowland et al., 2005) as it was in my specialism. My thorough understanding of the concept meant I was confident in both planning and asking probing questions (Wiliam, 2010), as well as responding to unexpected answers (contingent knowledge, 2005) to progress the learning. The next lesson will involve a concept I am not so familiar with and it will be important that I discuss with the science teacher so that I improve my foundation knowledge (2005) and pitch the lesson appropriately. Moreover, I must discuss my intended pedagogical choices (transformation knowledge, 2005) with Mr X before the lesson and explore possible common misconceptions (Scaife, 2008) so that I can support my pupils to make progress and achieve.

I plan to use a series of short activities to support the pupils to take part in group work towards the end of the lesson (Sherrington, 2019). I intend to make the connections between each activity (and how it supports the final group work) clear to the class (connection knowledge; 2005). The pupils will be given specific roles (2019) to ensure they take part appropriately during the group work. I will also ensure that E and G are further supported with resources that allow them to produce better written work. I observed that the class teacher used a 'key terms mat' (Wellington and Osbourne, 2001) to support these pupils so I will produce one for the next lesson to support the pupils' learning. I will also ensure the class are able to verbalise their arguments before undertaking the writing (2001).

Next steps:

To discuss the underlying concepts and common misconceptions with the class-teacher to ensure secure foundation knowledge.

To share my lesson plan and intended structured learning activities with my mentor to ensure appropriate use and development of my transformation knowledge.

To create a mat with key words for E and G (transformation knowledge).

Progress in Pedagogy

Assessment – use of more in-depth questioning and probing learners' answers. My ability to do this well is dependent on my understanding of the underlying concepts. I will continue to work on this aspect with my mentor (foundation knowledge).

Exploiting subject disciplines – ensuring I have a thorough understanding of concepts and knowledge, of common misconceptions and appropriate pedagogy to dispel misunderstanding. I will continue to improve my subject knowledge through the use of appropriate scientific texts and resources (e.g. from the WJEC) and to explore pedagogy in the literature (e.g. Sherrington, Wiliam, Scaife etc.) as well as observe science teachers teaching (foundation knowledge; transformation knowledge).

Appendix C

Semi-structured interview schedule questions

Trialling the use of the Knowledge Quartet

Welcome and remind what the interview is about and how long it will take. Check that we won't be disturbed.

Remind the participants that they do not have to take part and can stop the interview at any point without giving a reason.

Ask permission to record audio during the interview. (If audio is not permitted, permission to take notes will be asked.)

Remind that I am not looking for a particular answer or outcome; I am just interested in their opinions and perceptions.

Reminder I will nod to show I am interested but this may not mean I agree! I want them to feel comfortable in answering honestly.

Reminder they can choose not to answer any questions and they need not give a reason. Remind them I will send a transcript of the interview (or summary of notes) and they can check these for accuracy and ask for anything to be deleted at that point too.

Reminder that the interview will be about the Knowledge Quartet (show).

The interview will take about half an hour (students) and an hour (teacher educators).

Ask if they are happy for me to proceed.

Questions for mentor, tutor and student teacher

1. How long have you been a mentor/tutor (for student teachers: What area of science do you specialise in?)

2. Do you work with student teachers outside your specialism?

    a) Further questions/prompts: what phase, subjects?

3. Can you briefly explain how you did student teacher lesson observations previously?

    a) Further questions/prompts: What guided the observations?
    b) Does this change as the students develop?
    c) Do you offer more guidance at the start on specific aspects of teacher knowledge? (If so, what aspects?)
    d) What aspects of teacher knowledge do you tend to focus on when working with students outside your specialism?
    e) Is there any aspect of teacher knowledge that you tend to avoid when working outside your specialism?

f) In summary – what are the key advantages and disadvantages?

4. What aspects of teacher knowledge would have been discussed previously? Can you give me a concrete example?

5. In **what ways** is observing using the Knowledge Quartet useful to you as a teacher educator/student teacher
a) Can you give examples?
a) Does it help student teachers/you to meet the Professional Standards for Teaching and Leadership? If so, in what ways? Concrete examples?
b) Does it help student teachers/you to be aware of teacher knowledge? If so, in what ways?
c) Is it helpful to have one shared way of analysing lesson plans and observation for all student teachers? Or would a range of frameworks be more helpful?
d) If it is not helpful, please explain why? Is there something that would be more helpful?

6. What (if any) are the advantages and disadvantages of using the KQ when observing lessons/being observed)?

7. Is there any evidence that the student teachers improved their teacher knowledge following a discussion using this framework? Give me a concrete example.

a. Further prompts: please explain.

8. Did you develop your mentoring practice by using this knowledge framework? (Further questions/prompts: If yes, give me an example, how? If no, can you explain why?

9. In what ways could using the Knowledge Quartet be improved (teacher educator/student teacher)?

a. Is there anything that is missing?

b. How would you amend the KQ?

c. Does the KQ need to be simplified? Please explain.

d. Would any further information be of help? If so what?

10. When we discussed the KQ in June 2019, it seemed that transformation knowledge (student teachers considered it was foundation knowledge) was the most challenging to define. Is that still the case?

11. Also, when we discussed the KQ in June 2019, it seemed that having contingency knowledge was a marker of being a more well-developed, confident student teacher. Do you still think this is the case?

Prompt/Further question - are some of the other knowledge areas indicative of mature teacher development?

12. When we discussed the KQ in June 2019, we briefly discussed focusing on one or two main areas of knowledge at a time. Having used the KQ, how important do you consider focusing only on one or two areas of knowledge at a time?

Prompt/Further question: can you explain your answer?

13. Is there anything else you'd like to add?

14. Are you willing for me to use direct, anonymous quotes from this interview?

a) Yes
b) No

Thank-you for taking the time to answer my questions.

I will now transcribe our conversation (or make summary notes) and send you these to check for accuracy. You may request to change or delete these as required and I will remind you of this in the e-mail.

Thank-you for all your help and support.

Diolch.

Appendix D

Sample page of summary notes from interviews and key themes (in bold; including sub-themes).

The summary notes were coded by hand against the terms: Foundation, Transformation, Connection/connected, Contingency/Contingency knowledge, plan/planning, analysis/analyse, observation and reflect/reflection/reflective. Codes used to identify the four types of knowledge by Rowland et al. (2005) and Weston et al. (2013) were also used to analyse the data (see table 1). The data was also analysed against the research questions.

Question	**Respondent Lead Mentor 1, Lead School (Welsh medium)**	**Respondent Mentor Lead PGCE (Welsh medium)**	**Respondent Lead Mentor 2 Lead School (English medium)**	**Respondent Student teachers (five Welsh medium; five English medium)**	**Initial summary and key themes**
Question 9 In what ways could the Knowledge Quartet be improved? a. Is there anything that is missing? b. How would you amend the KQ? c. Does the KQ need to be simplified? Please explain. d. Would any further information be of help? If so what?	A It is teacher focused, as it is there knowledge. Perhaps the focus on pupils could be lost. Having said that, that is how they will develop by improving their teacher knowledge. Perhaps need to ensure a focus on the pupils. B Need a focus on the pupils to be clear. C. To begin with I thought so but now I think it's	A. Important to do these in order normally Foundation, Transformation, Connection and Contingency and then bounce around and have the pupils in the middle. B. Make it clearer transformation knowledge is used in context of pupils Could have further circles around it to build up your theories. From mentor and tutor perspective could be referencing the theory behind their choices. C. No but I think some mentors need	A Discussing this with the student teachers early on in their development is integral for the dialogue, I might try to do it earlier on. B.I don't know. C. Not it is pretty simple. D. Time to use it – so much better with more time. We don't have enough time.	a. No. More examples (ST1, ST2, ST3, ST5, ST6, ST7, ST8, ST9, ST10) b. how to deal with specific pupils who are challenging ST1). c. No (ST1, ST2, ST3, ST4, ST5, ST6, ST7, ST8, ST10). ST9 – yes, another explanation of how to use it before next placement. d. Want examples of lesson reflections written up using the	**To embed need more time, to practise using the KQ, guidance and training). Provide guidance to use it early on for dialogue during mentoring. Provide further guidance on the links between the KQ and a focus on pupil learning. Concept (teacher knowledge) and misconception. KQ offers a potentially helpful, simple tool. Offers possible categorisation of the knowledge**

	ok. The more you use it the easier it gets. D. Is it appropriate for the whole journey, should some aspects come later on?	more help to get the most out of it. If their analytical skills are not as well developed, they may not get as much out of it. I would not have got as much out of it nine year ago. D. Could we use this to analyse our sessions?		KQ. ST1, ST4, ST5, ST9, ST10	**required to teach (consider discussing categories in a specific order) by mentors. Provide further exemplars.**

Appendix E

Sample pages of findings from science student teachers' critical portfolios

Science students' critical portfolios were read and the coded by hand against the terms Foundation, Transformation, Connection/connected, Contingency/Contingent knowledge, framework, tool, plan/planning, analysis, observation and reflect/reflection/reflective. As the documents are long, for ease of identification the four types of knowledge codes were coloured as shown below. Codes used to identify the four types of knowledge by Rowland et al. (2005) and Weston et al. (2013) were also used to analyse the data (see table 1). Themes (see Appendix H) were assigned (including sub-themes) to the summary notes.

KQ category	ST1 Biology	ST2 Physics	ST3 Biology	ST4 Chemistry	ST5 Chemistry	ST6 Physics	Summary notes and key themes
Foundation Knowledge	A sound knowledge of the pupils and a basic understanding of the topic is not enough to teach engaging and informative lessons. I need to improve my subject knowledge (of chem and phys) so I can deal with unexpected answers. A lack of confidence in my topic information meant I did not correct a misconception in the lesson. Important that I know the areas I will struggle with at KS3 so I can spend time improving my knowledge in that area to be ready to teach. By showing my passion for biology I may be able to engage learners in the lesson. The observation focus for this	Due to my strong Foundation Knowledge, I was able to adapt and respond well to unexpected questions or answers from the learners. During this lesson once again I was familiar with the background knowledge since the lesson topic was within my specialism. However, I was not as confident in this biology topic. To combat this I ensured I did a large amount of background reading before planning the lesson and watched numerous video lessons on-line about the topic too all in order to refresh my	My beliefs are that everyone is a scientist and I will be telling this to the students. I had not realized what their written work was like until I looked in their books, but I had adapted my lessons to respond by the next lesson.	My degree is in Chemistry. Science teachers have expertise in one sometimes two, very narrow aspect of science. I need to improve my wider subject knowledge so I can better transform it for my students. In my specialism I felt confident and because of the high level of maths in my degree with numeracy.	Before the lesson I made sure I was aware of the pupils' levels so that the work was planned at an appropriate level. As I had not learnt about water since school, I had to ensure my subject knowledge was completely correct before teaching and by doing this I ensured I was able to answer the pupils' questions during the lesson. Before the lesson I thought I had good Foundation knowledge. By reflecting, I realise I have also developed knowledge of the curriculum,	I had never completed this practical within before so therefore had to conduct intensive research into the practical. I read through many methods of the model gut & how exactly it works, also finding an instructional video on the practical made for science teacher by a fellow science teacher giving ideas on how to conduct the practical as a demonstration. I used all this research to improve my foundation knowledge to ensure the subject knowledge on both the theory and the practical was clear before even started to plan the lesson.	KQ offers a possible categorization of teacher knowledge. The four categories are perceived to be related. Confidence in their knowledge appears to help students to employ their knowledge. Novices need to improve subject knowledge outside of their specialism. Dealing with unexpected answers or errors becomes an issue as they do not have the correct foundation knowledge. The amount of work the novices have to do to ensure their foundation knowledge is sound before planning a lesson can be significant, even for one lesson.

	lesson was differentiation, with my mentors hoping to see progress in my pedagogy by showing my ability to differentiate. Due to my sound foundation knowledge (Rowland *et al*., 2005) of the class, I found that I was able to differentiate the tasks for the lesson. I could easily identify the varying levels of capabilities in the class and planned the work and tasks accordingly. I feel I was able to supply learners with real life and authentic contexts throughout the lesson, which aided in their understanding of this abstract topic. The ability to supply context like this stemmed from a sound foundation knowledge (Rowland *et al*., 2005) that I believe I had.	memory of the sub-topic. By doing this I was able to supply myself with enough background information on the topic to answer their questions. Teachers' beliefs about how a teacher teaches may influences the methods they use to engage learners and help them produce high quality work.			the learners and pedagogy but I do need to work on what I believe about the nature of the subject.		Novice teacher beliefs may influence the pedagogy chosen.

Appendix F

Formal lesson observation form (Pedagogy Assessment Form; X, 2019) which includes space for student teaches' reflective report on their development.

Name	Mentor	School	Class	Date

Refining teaching
Managing the …. environment
Assessment
Differentiation
Subject knowledge and discipline
Four purposes for learners
Exploiting subject disciplines
Blended learning experiences
Real life, authentic contexts
Progression in learning
Cross-curricular themes
Influencing learners
Challenge and expectations
Listening to learners
Learners leading learning
Sustained effort and resilience
Reflection on learning
Welsh language skills

Overall progress in Pedagogy (in all lessons) Evaluative and summative comments with examples of teaching or learning.

Learner progress Summarise all learners' progress over time in all lessons. Comment on all classes, individuals and groups.

Is the student in need of enhanced support to progress?

Focus (agreed prior to observation) Refer to handbook

Lesson Observation Analyse significant incidents, activities and planning **relevant to the agreed focus. Ref to learning.**

Response to previous targets This summary should be based on the above including teaching seen in other lessons

Targets To be drafted **with** the trainee and not **for** the trainee.

The observed lesson was:	representative	not as effective as usual	more effective than usual	**Moderator**

Student Reflective analysis of teaching and learning

Progress in Pedagogy (200-300 words) Give particular attention to the targets of the observed lesson.
Next steps (100 words) What you need to do to improve, using your new targets as a focus

Pedagogy standards and references Link these to your next steps

Appendix G

Table to show science mentors' and student teachers' agreed foci for formal lesson observation, any link to the KQ and the wording of the Teaching Standards (called in Wales the Professional Standards for Teaching and Leadership, Welsh Government, 2019a).

Student teacher	Science mentor and student teacher's agreed focus for first formal observation.	Link to Knowledge Quartet	Science mentor and student teacher's agreed focus for second formal observation.	Link to Knowledge Quarter	Wording of foci in relation to the Teaching Standards	Focus on assessment ?
Biology	Aim to provide learners with the knowledge to extract information from food, what constitutes a healthy diet and how diet impacts health. Link to developing 'healthy, confident individuals' and the four purposes of the curriculum.	**Foundation Knowledge –** subject knowledge, knowledge of the curriculum. **Transformation Knowledge** Transforming correct subject knowledge into a form that helps the learners to learn. **Connection knowledge** Connected learning in one lesson to wider aims of the new curriculum and to pupils' long-term general health.	Reflect on learning and feedback from the pupils. Provide authentic contexts to foster development of subject knowledge and aid learning about an abstract topic.	**Transformation Knowledge** Transforming correct subject knowledge into a form that helps the learners to learn.	Provide authentic contexts Reflection on learning The teacher demonstrates knowledge of effective pedagogies. Ensuring the four purposes ("developing health confident individuals") are the drivers for the learners' experiences.	Yes in second observation.
Biology	Blended learning – learners use bioviewers, worksheets and watch video.	**Transformation knowledge** Subject specific and general strategies and procedures.	Manage learning environment. Plan engaging lessons which specify what learners will do and learn. Consistently ensure clear instructions and use of AfL strategies.	**Foundation Knowledge** Concentration on procedures. **Transformation Knowledge** Transforming correct subject knowledge into a form that helps the learners to learn.	Mange the learning environment. Blended learning. Assessment	**Yes in second observation**
Chemistry	Timing	**Foundation knowledge** Concentration on procedures.	Effective closure of the lesson	**Transformation knowledge** General strategies and procedures		No

Chemistry	Use of motivational starter and ensure effective pace	**Transformation knowledge** General pedagogical strategies and procedures.	Pupils to co-plan success criteria. Develop skills to assess pupils and differentiate.	**Transformation knowledge** General strategies and procedures.	Assessment Differentiate	Yes, in second.
Physics	Manage the scientific laboratory	**Foundation knowledge** Concentration on procedures.	Questioning – make sure all pupils take part and control the discussion. Think about what types of questions to ask – open, closed**.**	**Transformation knowledge** General pedagogical strategies.	Managing the learning environment Assessment	Yes in second
Physics	Manage the learning environment. Offer blended learning experience and progression in learning.	**Foundation knowledge** Concentration on procedures. **Transformation knowledge –** general strategies (may be some intimation of subject specific strategies too but this is not clear).	Plan engaging lessons and well-organized lessons.	**Foundation knowledge** Concentration on procedures. **Transformation knowledge –** general strategies.	Manage the learning environment Blended learning Progression in learning	Not mentioned specifically

Appendix H

Themes and sub-themes with interconnections (Braun & Clarke, 2006).