Investigating the extent to which informal mentoring by recently retired teachers of physics can support beginner teachers of physics to grow in their teacher knowledge and influence their retention in teaching

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Investigating the Extent to Which Informal Mentoring by Recently Retired Teachers of Physics Can Support Beginner Teachers of Physics to Grow in Their Teacher Knowledge and Influence Their Retention in Teaching

Abstract

The experiences of beginner teachers of physics in their first year of teaching and the factors affecting their intentions to remain in the profession are explored and contrasted with what is known from the literature. Findings from this include feelings of isolation, lack of subject specific support and low time availability of supportive colleagues in schools. These, and what is known about teacher professional learning, are used to inform a small-scale qualitative study of using recently retired physics teachers to informally mentor new teachers of physics over a period of one year. Case studies of the mentor and mentees are presented using data from the contents of mentoring conversations and these are analysed to explore the extent to which this type of informal mentoring can support professional knowledge growth in new physics teachers and influence their decisions to remain in the profession. Findings show that the main areas of professional knowledge addressed by the mentoring are behaviour management and pedagogical content knowledge (PCK). A key factor in the success of the mentoring was its informality and relationship to other forms of support and mentoring available to the new physics teacher. Implications for teacher educators about the benefits and limitations of this type of mentoring are considered and proposals for further study made.

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1. Introduction and Background

This study seeks to explore the experiences of beginner teachers of physics in their first year of teaching and their intentions about continuing in the profession. It then aims to conduct a small-scale inquiry into the effects of a voluntary intervention using recently retired physics subject specialist teachers to informally mentor these beginner teachers.

I review literature on the retention of early career physics teachers, teacher knowledge growth and mentoring, before moving on to describe the intervention and the case study methodology employed to study it. I then present the findings integrated with analysis that draws upon the literature and use this to tentatively suggest implications for my own practice as a teacher educator.

1.1 Physics Teacher Shortages in England

That there is a shortage of physics teachers in England is well known. A research brief by the Sutton Trust (Kirby and Cullinane, 2017) found that only 51% of those teaching physics in secondary schools have a specialist degree in the subject. A recent report from the Education Policy Institute (Sibieta, 2020) based on the school workforce data census in England found that this is because of shortfalls in both the recruitment and retention of new physics teachers. The numbers are striking. There was a recruitment shortfall of 718 physics teachers in 2019-20 alone (Foster, 2019). In retention terms, the percentage of newly qualified physics teachers still in service after 5 years has decreased from 60% in 2018 (Department for Education, 2018) to 50% in 2019 (Education Endowment Foundation, 2020). The argument is made that economic demand for physics graduates in alternative careers and better pay accounts for this (Sibieta, 2020), but is it the whole story? Are there issues raised by the way that physics teachers are educated and inducted into the profession that contribute to retention problems? Are there ways of addressing the problem that are shown not only to work, but also to support beginner physics teachers to grow in their knowledge of teaching? The costs to

society of the retention problem with physics teachers are significant. The Sutton Trust (2017) found that it is students from the most disadvantaged backgrounds that are the least likely to have teachers with relevant science qualifications and that this may affect social mobility. In purely financial terms, a recent report (Allen *et al.*, 2016) produced for the Institute for Fiscal Studies found that the average cost of training a new teacher in England is £23,000 and that secondary physics teachers are significantly higher than this average due to the large bursaries available to many students. Are there ways of investing public money in retention that may be more cost effective than a continual struggle to recruit and train?

In this study I will explore the issues that early career physics teachers regard as influential in their decisions to leave or remain in the profession. I will identify the kinds of professional knowledge that early career physics teachers need to be successful in the classroom and will then present case studies of beginner physics teachers who are participating in mentoring with recently retired teachers of physics. I will argue that informal mentoring interventions like this can support the growth of physics teacher knowledge in two main ways, knowledge of pedagogy and pedagogical content knowledge (PCK). I will go on to suggest that there is some evidence emerging to indicate that exploring this type of intervention further may lead to useful strategies for influencing the intentions of new physics teachers to remain in the profession. Given the cultural environment of secondary schools in England I will also make the case that recently retired teachers are strategically placed and particularly qualified to be able to provide this kind of mentoring support and discuss limitations with the approach.

1.2 Research Questions

The research question of this small-scale study is:

What is the extent to which informal mentoring from recently retired teachers of physics can support beginner teachers of physics to grow in their teacher knowledge and influence their retention in teaching?

To answer this fully I will break it down into five sub-questions:

1. What are some of the factors identified by newly qualified teachers (NQT's) in physics that influence their decision to leave or stay in the profession during the year post-qualification?
2. What areas of teacher knowledge are significant for early career teachers of physics and how can these be developed?
3. What is the evidence for external mentoring by retired teachers as an effective intervention to support physics teacher retention and teacher knowledge growth for early career physics teachers?
4. What are the ways and extent that informal mentoring of NQT's can be facilitated by recently retired teachers?
    a. What are the characteristics of teachers who benefit from this kind of mentoring?
    b. What are the specific contents of mentoring conversations between NQT's and recently retired mentors?
    c. To what extent does the contents of the mentoring address known knowledge bases of teachers and promote teacher growth?
    d. What are some of the limitations and challenges of this type of informal mentoring?
    e. How can recently retired teachers be supported as mentors?
5. What are some of the effects of this mentoring on the intentions of these NQT's to remain in the profession?

2. Critical Literature Review

2.1. Organisation of the Literature Review

The sections in the literature review will be organised around the first three research questions and end by summarising significant emerging themes. By critically reviewing literature on the themes of physics teacher retention, early career physics teacher knowledge growth and what is known about the impact of external mentoring on early career physics teachers, the case will be made that it is reasonable to put in place the intervention that is the focus of this study. This will involve recruiting retired teachers of physics to mentor early career teachers of physics to support their teacher knowledge growth and retention in the profession.

2.2 The Retention of Early Career Physics Teachers

The first part of this literature review considers sub-research question one which is: what are some of the factors identified by NQT's in Physics that influence their decision to leave or stay in the profession during the year post-qualification? For the purpose of this study I use the word retention in the same way as Ingersoll (2001) to refer to qualified teachers who leave the profession for reasons other than retirement. The terms 'wastage' and 'attrition' are also sometimes used, for example Smithers and Robinson (2008) and Glazer (2018) and these were also used for searching relevant literature.

The themes this section of the review will cover are: Factors influencing the retention of early career teachers, the significance of the first year after training and issues specific to physics teachers. I will critically reflect on the literature to argue that although much is known about teacher retention in general, there are issues specific to physics that are less well understood.

2.2.1 Factors Influencing the Retention of Early Career Teachers

The reasons why teachers leave the profession have been studied extensively. For example, in the United States Gonzalez, Brown and Slate (2008) found the three most significant contributing factors to be: lack of administrative support, difficulties with student discipline and low salary levels. And in England, Barmby (2006) found two main factors: workload and pupil behaviour. If these factors are grouped under a wider category of workplace conditions then the findings are in agreement with a large scale meta-analysis by Borman and Martiza Dowling (2008) who then suggest that these problems could be alleviated through policies and initiatives. This is contrary to what is popularly assumed – that the biggest factor is the socio-economic level of the school (Adams, 2016). In fact, Dupriez, Delvaux and Lothaire (2016) find no connection between the socio-economic level of the schools and intentions to leave the profession in a study of new teachers in Belgium nor in the United States in a study by Hughes (2012).

Entry into the teaching profession is sudden (Veenman, 1984, p. 143). A beginner teacher fresh from completing their initial teacher education can essentially have the same day to day classroom responsibilities as a veteran of forty years. The impact of the ensuing “reality shock” can have significant consequences for teacher retention as it is often easier for teachers to leave and find alternative employment in the early stages of their career before they have built up the specific non-transferable knowledge specific to teaching (Borman and Dowling, 2008). Gu and Day (2013) suggest that helping teachers to manage these uncertainties and the reality shock, through “support by wise leaders” would improve retention.

Narratives of new secondary modern foreign language teachers in the United Kingdom are used by Smethem (2007) to identify changing perceptions of what it means to have a career in teaching. The expectation of a single career is challenged as an assumption of the past, with some new teachers having intentions from the start to move to a different career after teaching for a time. This finding is supported to some extent by a small study of two science teachers in the USA by Gilbert (2011)

who found, based on analysing the professional journey of these teachers in detail, that some science teachers may enter the profession to develop new skills as a transition to another career such as in medicine.

There is some evidence that providing financial incentives to prospective teachers is effective in enticing them into the profession (Huat See, Morris, Gorard and El Soufi, 2020, p. 1) but only weak indications that it improves retention. Rather than being extrinsically motivated by financial rewards, the new teachers interviewed by Smethem (2007) report more intrinsic motivations around a sense of vocation. This intrinsic motivation is also apparent in a large study of long serving (ten years or more) teachers in England by Chiong, Menzies and Parameshwaran (2017, p. 1104) .They found that "perceived professional mastery" and "altruism" were the most commonly identified reasons for long-service. They suggest the two factors are connected because the teachers who "feel they are well placed to make a positive difference through teaching" are those who stay. Further support from Australia (Howes and Goodman-Delahunty, 2015) found that teachers' personal fulfilment was important to retention and a case study in the United States of the journey of a middle school teacher (Craig, 2014, p. 108) points to "her self-recognition that her craft was improving" as her reason for staying in the profession, despite the challenges she faced. This does suggest problems might occur when a teacher does not perceive themself to be improving or if they feel like they are prevented from being the teacher they would like to be. Schaefer, Downey and Clandinin (2014) found examples of such teachers who felt powerless in this position and as a result, chose to leave the profession.

Rushton and Criswell (2015) propose a solution to this potential inconsistency between the way beginner teachers actually see themselves and how they would like to see themselves; by developing a professional vision through working with more experienced colleagues. This is supported by a larger scale American study of novice teachers (Pogodzinski, Youngs and Frank, 2013) that also linked what they refer to as collegiality in a school, with intent to remain in teaching.

Zavelevsky and Lishchinsky (2020) suggest therefore that organisational practices in school must be designed to be conducive of retention by providing support and mentoring. Unfortunately, one of the most reported on features of life as an early career teacher is isolation (Tye and Tye, 1984; Hillier, de Winter and Twidle, 2013; Gilbert, 2011). This is often expressed as a feeling of disconnection from colleagues and school leadership and a lack of appropriate support. Another challenge to the solution of Rushton and Criswell (2015) is highlighted by Locke (1993) who when investigating the lived experience of early career biology teachers in England identified three main problems they faced: unsupportive colleagues, the discipline of children and unsupportive heads of department. This suggests difficulties in the relationships between new and more experienced teachers that may prevent effective support from being realised. A further challenging finding by Weiss (1999, p. 869), who investigated beginner teachers in the United States, points out the particular vulnerability of early career teachers to "unsupportive workplace conditions", one factor of which is explained as schools where there is a lack of opportunity to collaborate with other teachers, often at an organisational level. This backs up an earlier finding of Chapman and Green (1986) who incorporated early work experiences into their model of teacher retention based on extensive study of a large sample of teachers graduating in Michigan in the United States. Recently, Sims (2019) also found links in England between the working condition of teachers, job satisfaction and retention. He goes on to suggest that to improve all of these, teachers should be: asked to teach the subjects they have degrees in, offered subject-knowledge training where appropriate and also have scope for progression (which is understood not to just about formal promotion but also about the provision of professional development).

In summary, problems with the retention of early career teachers are well known but difficult to solve. Simple solutions that seem on the face of it attractive, such as offering financial incentives are found to be ineffectual in the context of new teachers who are motivated more by a desire to do good and feel personal fulfilment. Following on from this, a suggestion to address the retention of

new teachers seems to be the need for new teachers to work in professional communities that will actively support both their self-image as effective teachers and personal professional development.

2.2.2 The Significance of the First Year Post-Qualification

Teachers in their first-year post-qualification are very mobile. In England the most recent data confirms that 15% of the 2016 first year teacher cohort left by the end of the academic year (Sibieta, 2020). Other countries report similar findings. In the United States Redding and Henry (2019) show that even before the end of the first year, 8% of new teachers have either moved school or left the profession. They recognise that in these numbers it is not possible to distinguish between those who move voluntarily and those who do not, but this figure is much higher than for teachers in any other part of their career. Government policy in England is currently attempting to address the issue by introducing the Early Career Framework (Department for Education, 2020a) which provides a structured two-year package of professional development for new teachers starting in September 2021 to improve their experience at the start of their careers.

This initial experience is important. A study of new Canadian teachers (Goddard and Foster, 2001) found a link between experiences during this initial year and decisions they make subsequently about whether or not to stay in the profession, as well as the degree to which they become able to make progress in developing their professional skills. This finding is shared by Luft (2009, p. 2365) who notes particular problems with new science teachers being “constrained in their beliefs, PCK, or instructional repertoire” if they lack adequate support from other subject specialist teachers during the first year. The first year of teaching is also one in which new teachers shape their own sense of professional identity (Pearce and Morrison, 2011) and case study research in Australia showed that if done consciously and positively in relationship with others, this can enhance teachers’ resilience. Dupriez, Delvaux and Lothaire (2016) also found a link between the job conditions of teachers in Belgium in their first year and their subsequent retention in the profession. A possible reason for job

conditions to have such an effect is suggested by Weiss (1999) in terms of the finding that first year teachers remain in the profession if they are socialised successfully into a collaborative work ethic in a school. Concerns as to how often such a collaborative work ethic is achieved are raised by Featherstone (1992, p. 14) however, who found that often new teachers are expected to learn "by osmosis" how to meld together what they have learned in their training with what they find is actually possible in their new school.

There are also sometimes uncertainties about the exact role the new teachers inhabit in a school and this was found by Fimian and Blanton (1987) to cause problems that are a particular cause of stress. Another cause of uncertainty and stress for new teachers is identified by Zapeta and Ponticell (1997) in the United States, who find that navigating the complex pre-established power relationships that exist between staff in schools can be challenging. They also found that school leaders were often keen to capitalise on the enthusiasm of new teachers by adding burdensome extra responsibilities on top of their classroom duties, such as leading extra-curricular activities. A recent study by Gray, Lambert and Jefferson (2020) of the experiences of new drama teachers in Australia found the same issues. All these contributed to the teachers' perception of their working conditions, stress and ultimately their intentions to remain in or leave the profession. Interestingly, Hoigaard, Giske and Sundsli (2012) found that an indicator of intention to quit for an early career teacher was absorption in the job, as this was often a predictor of burnout. The work of Hong (2012) on understanding the reasons why some teachers stay and some leave provides some insight by relating this to stressful, unrealistic, heavy burdens of work load imposed on themselves by some early career teachers. For Hardy (1999, p. 121), in a study of first year physical education teachers in England this was also recognised as a danger leading to the conclusion that "psychological support" is an important element of new teacher induction programmes and must go beyond just supporting new teachers to just learn how to survive. For Mclean, Abry, Taylor and Gaias (2019, p. 11) this type of "sink or swim" attitude to support in the first year needs to be rejected in favour of improving

professional relationships between the new teachers and colleagues that facilitate the sharing of ideas.

In summary the first year of teaching sees many new teachers deciding to leave based on their perceptions of their experiences. Despite many causes of stress being identified, it is suggested that appropriate support from colleagues can improve this experience and influence retention.

2.2.3 Issues Specific to First Year Physics Teachers

A major issue in the retention of physics teachers is the pay gap between what a physics teacher might earn on average and the comparative salary of peers in other professions (Sibieta, 2020, p. 28). Data from 2017-18 shows that this gap is pronounced for both men and women who can both expect to earn on average around £3000 less per year between the ages of 22 and 29 than their peers going into professional science or engineering careers. Another issue that came to light in the wide-ranging inquiry into physics in secondary schools in England by Smithers and Robinson (2008), is that of the suitability of some new physics teachers for teaching. Comments from a range of teacher educators indicate that for some new physics teachers their view of the nature of physics conflicts with how they are asked to teach it in school, or their love for the subject of physics is not combined with a personality that easily learns effective classroom management skills. A psychological study of physicists (not physics teachers but most new teachers of physics come from physics degree backgrounds) by Wilson and Jackson (1994) found one of the prevailing personality characteristics to be unsociability which may influence new physics teachers' ability to make meaningful relationships quickly when starting their first job. Another issue, highlighted by Childs and McNicholl (2007) in their study of new and experienced science teachers teaching outside their subject specialism, is the degree to which being faced with the necessity of teaching a large amount

of biology and chemistry can be perceived negatively. They suggest that new physics teachers may feel that they lack the subject knowledge to do this satisfactorily, as well as the PCK to respond to unexpected developments during practical work. This is supported by Smithers and Robinson (2007, p. 29) who found that one of the features of successful physics for students in comprehensive schools was "teaching physics as physics" and recommended therefore that chemistry, biology and physics should all be taught by subject specialists to reflect the different knowledge and pedagogy required in each. Related to this is the point raised by Hiller, de Winter and Twidle (2013) that, because of the shortage of physics teachers in many state schools in England, the opportunities for first year teachers to learn informally from colleagues in school is absent because they are the only specialist physics teacher in the schools. This, they argue is significant because it slows down the rate at which new physics teachers develop the pedagogical and conceptual knowledge they need in their own subject to become confident practitioners. Coupled with the lack of opportunity for learning as a new physics teacher, they also identify a trend where new physics teachers are sometimes given early responsibility (for example as a course leader for key stage five physics), because they are the only teacher in the school with relevant qualifications or as a way of incentivising the teacher to stay at the school. If the new physics teacher is unprepared for this responsibility however, it can have the opposite of the intended effect and lead to more disillusionment with teaching.

More literature on the experiences of first year physics teachers as a unique group within the wider context of schoolteachers in England would be useful to obtain more insight into the specific challenges they face.

2.2.4 Summary of Literature on the Retention of Physics Teachers

From the literature on the retention of teachers the key issues seem to be the establishment of positive working relationships in the first year to help new teachers learn how to navigate the

complexity of the school environment and be able to develop the pedagogical skills necessary for them to perceive that they are able to be the teachers they want to be. Often mentioned is the struggle that new teachers have with managing the behaviour of students. Additional problems specific to physics teachers are that: leaving the profession is more financially attractive than for teachers of other subjects, the opportunities for them to form positive professional relationships with more experienced physics teacher colleagues are more limited, the personality characteristics of physics teachers sometimes impact their success and physics teachers are often asked to teach out of specialism.

2.3 The Teacher Knowledge of Beginner Physics Teachers

The second part of this literature review will consider research sub-question two which is: what areas of teacher knowledge are significant for early career teachers of physics and how can these be developed? To broaden the evidence base on which to draw it will follow the finding of Kagan (1992, p.129) that "preservice and first-year teaching appear to constitute a single developmental stage" and that of DeAngelis, Wall and Che (2013, p. 338) of "the importance of considering preservice preparation in combination with induction support" for new teachers. These studies, a meta-analysis of 40 related research articles and a large scale (n = 4974) empirical study of new teachers from a single state in the United States respectively, provide good evidence that learning for new teachers continues after the formal one year training program in England is over and extends into the early career stage. They also suggest therefore, that ideas about how to support teacher knowledge growth in pre-service may also be useful in the transition to early career. The themes this section of the review will explore are: How do early career teachers grow in their professional knowledge? The professional knowledge that is important for early career physics teachers and, the ways and extent to which this teacher knowledge can be developed.

2.3.1 Early Career Teacher Professional Knowledge Growth

As has already been considered, the first year of teaching post-qualification is very significant. Evidence suggests that new teachers need support to develop their own sense of professional identity (Luft 2011; Pearce and Morrison, 2007). Kagan (1992) agrees that in this first year teachers reconstruct their personal image of self as a teacher and also adds that they begin to develop standard procedural routines, for example how to integrate classroom management and instruction, which are not often not fully developed during initial teacher education. It has been thought in the past that the process by which this teacher knowledge grows has been essentially linear in character. For example, Guskey (1986) conceived of a model (Fig. 1) where a teacher development intervention was put in place which resulted in a change in classroom practices, a change in student learning outcomes and then a consequent change in teacher beliefs and attitudes.

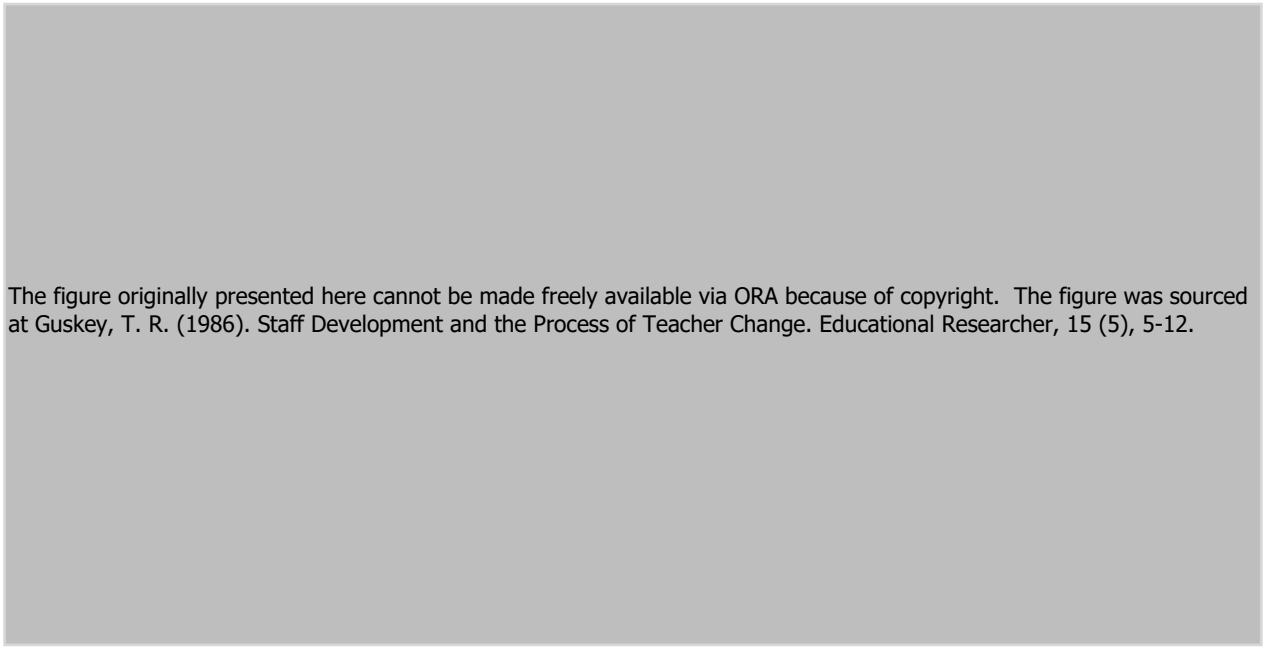


Figure 1 Guskey's model of the process of teacher change. (Guskey, 1986, p. 7)

This has however been challenged more recently by Clarke and Hollingsworth (2002, p. 951) who propose a more complex interconnected model of teacher development (Fig. 2) where growth occurs in any of four distinct domains of the teacher's world: the personal, practice, consequence

and external. This growth is then mediated though the processes of reflection and enaction. In this process, the "change environment" of the teacher, referring largely to the school context, must be conducive to the professional growth. The model also stresses that there are many different possible pathways through this network for a teacher. The model further suggests that any attempt to support lasting teacher knowledge development must attempt to create the conditions for these growth networks by facilitating reflection and enactment so that change occurring in one domain may lead to growth in the others.

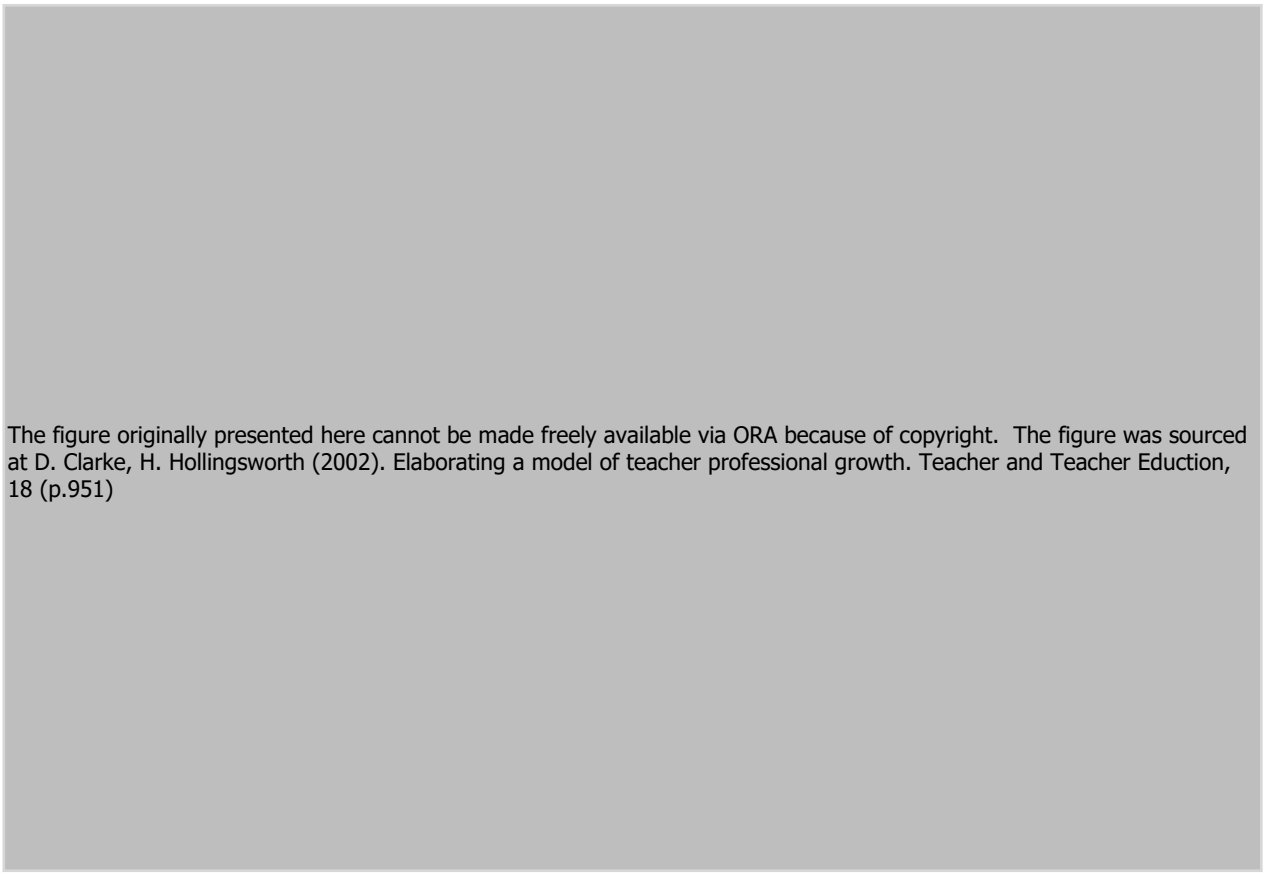


Figure 2 The interconnected model of teacher professional growth (Clarke and Hollingsworth, 2002, p. 951)

For Bishop and Denley (2007, p. 215) a concept of a change environment is also important for a "continuously learning science teacher". They see this as a community of teachers who facilitate each other to make meaning from their experiences, echoing ideas of reflection and enactment from Clarke and Hollingsworth (2002). For Shulman and Shulman (2004) also, teacher learning happens

within a community, but they broaden it out from the school to also include polity and profession. This reflects the issue that personality and availability may challenge the ideal of a learning community of teachers in an individual school. In summary, teacher growth is crucial for establishing new teachers' sense of self as a teacher, happens in a non-linear way and is situated within a conducive learning community. This raises questions for physics teachers in particular as the teacher shortages mentioned above limit the opportunity for new physics teachers to join a physics specific learning community.

2.3.2 The Teacher Knowledge Important for Early Career Physics Teachers

In attempting to define the particular knowledge of a teacher, Schulman (1987, p. 8) introduced the concept of PCK as:

> "that special amalgam of content and pedagogy that is uniquely the providence of teachers…the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction."

Sometimes criticised for being vague or too teacher centred (Kind, 2009) or being "just another piece of jargon" (Loughran, Berry and Mulhall, 2012, p. 12) it has nonetheless become an important construct for discussions of teacher knowledge, being explained as "that knowledge which is unique to the expert teacher" (Lederman and Gess-Newsome, 1992, p. 16) and therefore crucial to the development of early career teachers as they adapt to life in school. Lederman and Gess-Newsome (1992) also point out the contested nature of what specifically constitutes PCK. Lee and Luft (2008, p. 1346) attempt to provide clarity by reviewing a number of different conceptualisations of PCK and find that common components are the "representations and strategies" by which a teacher makes

their subject knowledge comprehensible to students and the "student learning and conceptions" as the teacher attempts to understand how the nature of the subject will be understood. Important as these issues are, Shulman (1987) readily acknowledged that PCK is not the only form of teacher knowledge. He placed it among seven knowledge bases of teachers, these being: content knowledge, general pedagogical knowledge, curriculum knowledge, PCK, knowledge of learners and their characteristics, knowledge of educational contexts, knowledge of educational ends and purposes and values. Barnett and Hodson (2000), in the context of attempting to examine secondary science teachers' views on their own teacher knowledge, simplify these into a model they propose called pedagogical context knowledge which encompasses four parts: academic and research knowledge, pedagogical content knowledge, professional knowledge and classroom knowledge. The teachers own knowledge sitting somewhere in the centre of these which are all further situated within the educational knowledge landscape (Fig. 3).

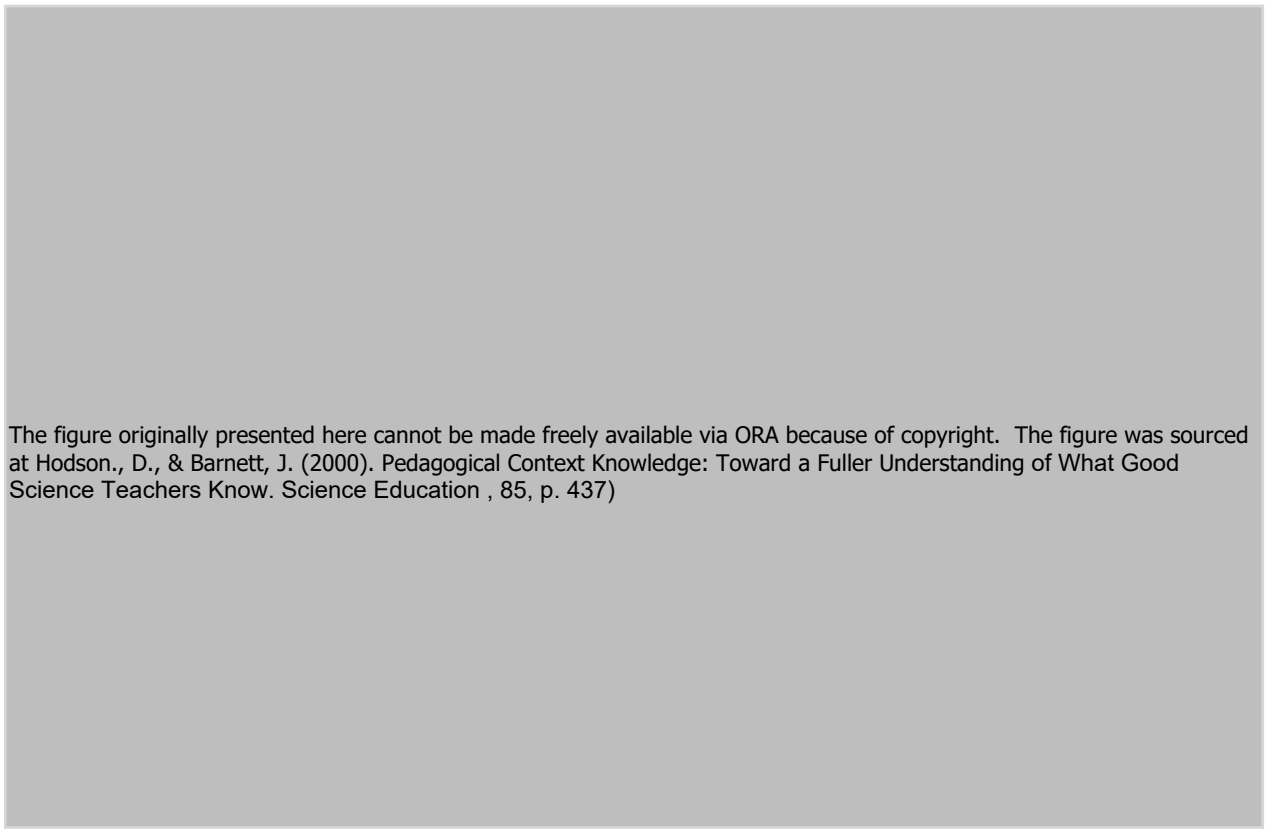


Figure 3 Pedagogical Context Knowledge (Hodson and Barnett, 2000, p. 437)

Some strengths of this model are that it shows distinctly that some elements of a teacher's knowledge are common to others who are not teachers, for example, academic and research knowledge. The model also emphasises the context specific nature of teacher knowledge. Where this model is in conflict with the wider studies of PCK by Lee and Luft (2008) is that much of what Hodson and Barnett (2000) consider to be classroom knowledge or indeed professional knowledge would sit more simply within a broader definition of PCK itself. Hodson and Barnett (2000) do also discuss the professional knowledge of teachers as that which is specific to the informal, cultural, practical, 'real world' of the day to day life of the teacher. They argue that the science teachers in their study thought that teacher educators know very little about this, which suggests there is evidence for a potentially dangerous theory/practice divide in considering how to develop the knowledge of pre-service and early career teachers. A way forward in considering the specific teacher knowledge of physics teachers is in a simpler representation suggested by Etkina (2010) who draws upon the work of Shulman (1987) and others to propose the structure of physics teacher knowledge having two facets of content knowledge and pedagogical knowledge whose overlap is PCK as seen in Fig. 4.

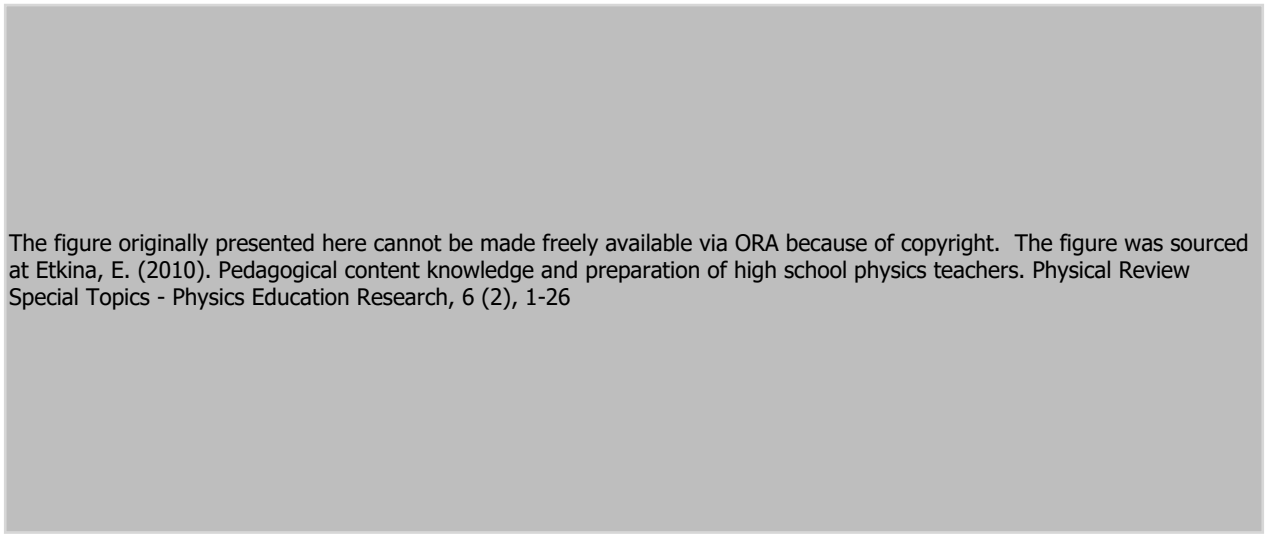


Figure 4 The structure of physics teacher knowledge (Etkina, 2010, p. 2)

This conception of physics teacher knowledge to some extent contains the representations and student conceptions of Lee and Luft (2008) as well as the context specific professional knowledge of Hodson and Barnett (2000). An example is given of this in practice by De Winter and Airy (2020) from a physics lesson in school where a physics teacher combines their content knowledge of Newton's laws, their knowledge of pupil misconceptions of these laws and knowledge of how to manage pupil behaviour into physics PCK. This is all then situated within the particular context of a school whose rules, routines and culture influence how this PCK is enacted. As this is a specifically physics based conception of teacher knowledge, I will use it in this study of early career physics teachers as a basis for understanding their teacher knowledge growth.

2.3.3 Ways in Which Early Career Teacher Knowledge Can be Developed

Burn, Hagger, Mutton and Everton (2003) criticise long standing views of teacher knowledge development that hold that beginner teachers are initially preoccupied with self before shifting their concern outwards to the needs of students. Instead they found that beginner teachers were in many cases very concerned for the needs of their students but struggled because they fell below their own aspirations in being able to meet the students' learning needs.

Berliner (2004, p. 206) introduces a different perspective and proposes that teachers develop from beginner to expert in the same way as experts in other fields and can be thought of as moving through five stages of development: novice, advanced beginner, competent performer, proficient, expert. The first, novice stage is characterised by the learning of context free rules to inform classroom practice and gain experience. This is largely done in initial teacher education. Progression through and beyond this requires external support, for example coaching with a more expert teacher, and then gradually transitions to a more self-regulatory process. In the advanced beginner

stage, the teacher now has some experience to draw upon and integrate with the rules they have previously learned. They may be able to recognise features of the classroom and start to make more considered decisions about what to do in any given situation – what he terms “case knowledge”. Professional competence follows this. In this stage theory of teacher growth Berliner (2004) draws upon the work of Dreyfuss and Dreyfuss (1986) to go further and suggest that most teachers may in fact never progress to becoming proficient or expert and this is not related to length of service or age. This finding is echoed by Tsui (2009, p. 437) who distinguishes between veteran and expert teachers and suggests that one way of becoming an expert teacher is to become a mentor to a novice teacher and be forced to “articulate the rationale behind their pedagogical actions”. This resonates with the findings of Kind (2009) that making the PCK explicit in the process of teaching by, for example articulating pedagogical reasoning, supports the development of both the expert teacher who is explaining and the novice teacher who is listening. Kind (2009) again draws attention to the domain (or context) specific nature of the knowledge of the expert teacher.

Barnett and Hodson (2000) describe an expert teacher as one who can distil their own classroom reasoning into overarching principles that can be explained to others and suggest that PCK can be developed faster among networks of teachers who practice in different contexts. This is understandable using the conceptual apparatus of Lave and Wenger’s (1991) communities of practice where teachers are able to compare their own practice with those in other contexts and so engage in the process of legitimate peripheral participation to accelerate their own development and participate fully in the community. Luft (2009, p. 2380) found in a study of first year science teachers in the US that despite attempts by schools to create this community by providing new teachers with official mentors, it was the “teacher next door” in close proximity, available and empathetic who most often filled this role.

In England also, new teachers are provided by their schools with more experienced mentor teachers to support the development of teacher knowledge. In a study by Williams and Prestage (2002, p. 43),

to ascertain the effectiveness of these arrangements they found that mentoring worked best when it was spontaneously collaborative in which interactions between mentor and new teacher were informal and unplanned. This they found was “not amenable to formal management”. They also found that the mentors involved in the development of the new teachers sometimes struggled with their role, recognising that one element of the relationship was to “weed out” unsuitable entrants to the profession. This element of assessment being at times in conflict with offering support.

Hobson and Maxwell (2017) bring in the idea of teacher well-being to this discussion as another responsibility of a mentor, which when practiced, led to more collegiality amongst teaching staff that may be linked to the communities of practice described above.

2.3.4 Summary of Literature on The Teacher Knowledge of Beginning Physics Teachers

In reviewing literature on the teacher knowledge of beginner physics teachers, emergent important themes are; the need for knowledge growth in the first year to support the development of a professional identity as a physics teacher, the significance of PCK as an element of this teacher knowledge and the importance of being part of a community of practice who can offer empathy, availability and informality to support progression from novice to competent. All this suggests that the school context in which the new teacher works is very important. An ideal environment would have a range of expert physics teachers who can provide informal support, wider connections to specialist teachers in other contexts, and an available and empathetic induction mentor. As previously argued, this type of experience may be challenging to find.

The next section of the literature review will consider the extent to which external mentoring by retired physics teachers can be effective in developing early career physics teacher knowledge.

2.4 External Mentoring by Retired Teachers as an Intervention to Support Early Career Teacher Knowledge Growth and the Retention of Physics Teachers

This part of the literature review is concerned with addressing research sub-question three which is: What is the evidence for external mentoring by retired teachers as an effective intervention to support physics teacher retention and teacher knowledge growth for early career teachers?

2.4.1 Defining External Mentoring

Following the lead of the report by the Gatsby Foundation (Hobson *et al.,* 2012) into the impact of external mentoring for physics teachers I will use a broad working definition of mentoring that encompasses what may be referred to by some teachers and in some literature as 'coaching'. External in this context means the mentor is not working in or employed by the school of the teacher being mentored (Hobson *et al.*, 2012). Parsloe and Wray (2000, p. 22) define mentoring as;

> "to help and support people to manage their own learning in order that they may maximise their potential, develop their skills, improve their performance, and enable them to become the person they want to be."

Clutterbuck (2001, p. 3) summarises mentoring as "offline help by one person to another in making significant transitions in knowledge, work or thinking." These two definitions have similarities in that they are both relational and have as their purpose the help of an individual in the relationship. Where there are different ideas is in how the purpose of mentoring is not just to help someone improve but to enable them to navigate a significant transition. This along with the idea of the person becoming who they want to be resonates with some of the frustrations of early career teachers considered above. An additional element included by Clutterbuck (2001) is the notion of mentoring being "off-line". By this it is meant that a mentoring relationship should not be one where one person has authority over the other as this would lead to conflict and a potential withholding of

information which could potentially damage the relationship. Richter *et al.* (2013), in their large study (n=700) of the mentoring of beginner mathematics teachers in Germany also consider psychological support as a goal of mentoring as it is associated with building resilience and well-being. Applying these ideas to the current project, mentoring will therefore be:

- A relationship between an early career physics teacher (mentee) and a retired physics teacher (mentor).
- For the purpose of helping the early career physics teacher develop their teacher knowledge.
- Supportive of the mental well-being of the early career physics teacher.
- To enable the early career physics teacher to transition into the role of a teacher successfully.
- Not a power relationship – there should be no role of authority between the mentor and mentee.

2.4.2 Mentoring Early Career Teachers to Support Teacher Knowledge Development

Studies have shown that mentoring for early career teachers is beneficial and can improve job satisfaction, skills development, and retention (Wang and Odell, 2002; Hobson, Ashby, Malderez and Tomlinson, 2009). This section will focus on how external mentoring can support early career physics teacher knowledge growth and retention. In evaluating the national Stimulating Physics Network (SPN) mentor program run by the Institute of Physics on behalf of the Department for Education between 2009 and 2012, Hobson *et al.* (2012) found that the mentoring (which in this case was by experienced teachers of physics, some of whom were still teachers and others were recently retired or combining the mentoring with other consultancy work) had extensive positive impact. This included: increased confidence in subject knowledge of physics, reassurance of having someone to

turn to in times of need, reduced feelings of isolation and stress and some indications of positive effects on physics teacher retention. Many factors influenced the extent to which impact was realised including: the mentors having credibility, availability, the personal skills necessary to build trust, regularity of contact between mentor and mentee and the mentors' independence from the assessment of the mentee. These findings are limited as they draw only upon the participants' own accounts of their experience but appear to show a strong indication that external mentoring can be useful for early career physics teachers. The role of mentors in this project also addressed the self-identity issues of early career physics teachers (Cameron and Grant, 2017) by providing links to a professional community facilitated by the Institute of Physics beyond and in many cases not available in, the confines of their own school (Luft, 2009). Surrette (2020) concurs with these benefits and adds that early career science teachers in the United States showed progress in their teacher knowledge evidenced by the variety of pedagogical approaches used in their classrooms after interacting with informal mentors from outside their school. The specific content of the conversation taking place in these types of mentoring relationships and how this improvement is fostered remains elusive in the literature and is an area this study seeks to address.

2.4.3 Retired Physics Teachers as Mentors

With the focus of attention on the recruitment of new physics teachers and then addressing retention issues relating to them, a neglected segment of the physics teaching profession is those who have recently retired. Despite being utilised on a small scale in the Institute of Physics Stimulating Physics Network project as described above by Hobson *et al.* (2012), a literature search found only one other instance of retired teachers being used in a mentoring role for new teachers. This was in the work of Gold (1987) describing a large project (~100 mentors) in New York where retired teachers were paired with new teachers in schools identified as having poor teacher

retention. Evaluation showed the mentoring was highly valued by the schools and teachers and led to small increases in retention of early career teachers. Strikingly however the most significant finding was the enthusiasm of the retired teachers for working as full-time mentors. Many of them reported not seeing themselves as retired and were delighted to still be able to contribute by "using their experience to help the newcomer" (Gold, 1987 p. 15). For Alvy (2005) it is important to prevent the loss of wisdom in schools that the retirement of these teachers represents. This is not to say that because a person has been a teacher for a long period of time, they are necessarily an expert. In the work of Gold (1987) the retired teachers were engaged if a positive reference from a previous head teacher was received and then they were given training in their new roles as mentors. In terms of willingness to participate, as Botwinik and Rothman Press (2006) point out, financial imperatives mean that many retired teachers will be seeking further employment later into life so further study into the effectiveness of retired teachers as mentors is timely and potentially important.

2.4.4 Summary of Literature on External Mentoring as an Intervention to Support Early Career Teacher Knowledge Growth and Retention of Physics Teachers

From the literature on mentoring there are clear principles to guide effective mentoring relationships and these have been set out in the context of this study. Within the context of these types of mentoring relationships it is hoped that there are then suitable conditions for teacher knowledge growth in terms of the early career physics teachers' opportunity to benefit from the pedagogical knowledge, physics teacher community links and empathy of the mentor. The studies mentioned show that there is meagre qualitative evidence for the effectiveness of such arrangements in the context of physics teaching, but the literature is not particularly developed nor is there recent work specifically targeted at using retired teachers as mentors. This study aims to add to the knowledge of both.

2.5 Summary of the Literature Review

This literature review has considered some of the known factors that influence the decisions of early career physics teachers to stay or leave in the profession, the areas of teacher knowledge significant for early career physics teachers and the possible role of external mentoring by retired physics teachers in addressing teacher knowledge and retention. In doing so the rationale for the intervention described in this study becomes very clear. I would argue that there are specific identifiable issues particular to early career physics teachers that lead to problems in retention. Isolation and a consequent lack of opportunity to form meaningful professional relationships with other subject specialist physics teachers may harm the formation of physics teacher self-identity. The types of teacher knowledge important for early career physics, for example PCK, are developed in the context of a physics teacher community of practice that if absent in the school environment could potentially be provided by an external, retired physics teacher mentor. The extent to which this occurs in a small sample of early career physics teachers will now be presented in the rest of this study.

3. Methodology

Having set out the research questions, the rationale for why this study is important in my own teacher education context and then critically reviewed relevant literature, I will now explain the methodology of the proposed mentoring intervention and justify the use of qualitative research methods and case study to obtain valid data.

3.1 Theoretical Positioning

The overall research question is: what is the extent to which informal mentoring from recently retired teachers of physics can support beginner teachers of physics to grow in their teacher knowledge and influence their retention in teaching? The nature of this question involves exploring the perceived experiences of a small number of beginner teachers of physics as they live through the first year of teaching post-qualification with respect to their interaction with a mentoring intervention and their intentions for future action. This suggests that an interpretivist ontological stance of research design involving the collection and analysis of qualitative data from the participants will be suitable to address it (O'Donoghue, 2007). This will "retain the integrity of the phenomena being investigated" (Cohen, Manion and Morrison, 2007 p. 21) by allowing the participants to set out their own understanding of the meaning and implications of events in their own world and yield diverse insights from which shared meaning can be inferred. As a researcher I also inhabit an additional active role as a teacher educator, linked to the participants by providing professional development and am so collaborating as part of this lived experience (Waring, 2012) in addressing the problem of early career physics teacher retention.

There are both therapeutic and political aims to the research (Coe, 2012). Therapeutic in that contributing to the knowledge of ways to improve early career physics teacher retention might potentially help many new physics teachers with great potential, who might otherwise leave the

profession in frustration and disappointment before their latent abilities have been fully realised. In a political sense, there is a social justice implication of both the recruitment and retention of physics teachers. The Social Mobility Commission (2017) has found that there is a link between geographical areas with high teacher turnover and the number of secondary school pupils eligible for free school meals. Physics has the highest turnover rate of teachers for any secondary subject (Smithers and Robinson, 2008) implying that for a child attending school in one of these areas one of their many disadvantages may be, not just a lack of a physics teacher, but a lack of a consistent physics teacher able to potentially have some positive effect on their experience of physics. This finding is also international. The OECD (2012) made the same link and recommends retaining high quality teachers as being key to improving student achievement. Another political motivation for the study is to inform a discussion about the economic value of measures to increase the number of physics teachers in England. The impact of large bursaries deemed to be necessary to boost recruitment (Department for Education, 2020b) could be compared with the retention effects of more modestly priced mentoring interventions such as those suggested here. It is hoped then, that new knowledge in this area could have the potential to inform policy decisions around the mentoring of new physics teachers and measures to improve retention.

3.2 Case Study Methodology

A case study has been defined by Robson (2002, p. 78) as:

> "A strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence".

This methodology is appropriate for this study because the case being explored will be the phenomenon of physics teachers in their first year of teaching with the intention of revealing the factors that influence their retention in the profession and also the ways and extent that informal mentoring from recently retired teachers can support their teacher growth. Evidence will be sought from both the physics teachers and the retired mentors who will be asked to report on their experiences of the mentoring. Yin (2009) suggests that a case study has the potential to evaluate and explain, for example in this context of investigating the effectiveness of the mentoring intervention. Case study is used for this purpose with caution however taking note of Thomas (2011, p. 31) who points out that any case study is limited to "a particular representation given in context and understood in that context." Care will therefore be taken to present a full description of the data without overclaiming the generalisability of any findings that emerge. The case selected in this study has been done using the rationale of Yin (2009) to be representative of the lived experience of early career physics teachers and also revelatory in the case of mentoring with retired physics teachers which has not been previously investigated. The unit of analysis in this study on the efficacy of mentoring of early career physics teachers in the first year of teaching by recently retired physics teachers and the impact on retention will have within it embedded four case studies that provide different perspectives on the overall case and address the key research questions as shown in table 1.

Embedded Case Study	**Research Questions Addressed**
Physics teachers in the first year of their careers with no external mentoring	1. What are some of the factors identified by NQTS's in physics that influence their decision to leave or stay in the profession during the year post-qualification?
First year physics teachers who are engaging in mentoring by a retired physics teacher,	4. What are the ways and extent that informal mentoring of physics NQT's can be facilitated by recently retired teachers of physics? a. What are the specific contents of mentoring conversations between physics NQT's and recently retired physics teacher mentors? b. To what extent do the contents of the mentoring address known knowledge bases of teachers and promote teacher growth? c. What are some of the limitations and challenges of this type of informal mentoring? 5. What are some of the effects of this mentoring on the intentions of these physics NQT's to remain in the profession?
First year physics teachers who are experiencing challenges engaging with mentoring by a recently retired physics teacher,	4. What are the ways and extent that informal mentoring of physics NQT's can be facilitated by recently retired teachers of physics?

	a. What are the specific contents of mentoring conversations between physics NQT's and recently retired physics teacher mentors? b. To what extent do the contents of the mentoring address known knowledge bases of teachers and promote teacher growth? c. What are some of the limitations and challenges of this type of informal mentoring? 5. What are some of the effects of this mentoring on the intentions of these physics NQT's to remain in the profession?
The perspective of a recently retired physics teacher mentor.	4. What are the ways and extent that informal mentoring of physics NQT's can be facilitated by recently retired teachers of physics? a. What are the specific contents of mentoring conversations between physics NQT's and recently retired physics teacher mentors? b. To what extent does the contents of the mentoring conversations address known knowledge bases of teachers and promote teacher growth? c. What are some of the limitations and challenges of this type of informal mentoring? **4d. How can recently retired teachers be supported as mentors?**

Table 1 How embedded case studies address the research questions. In bold is the sub-question only addressed by one embedded case study.

Research sub-questions two and three are primarily addressed through the review of literature presented above and which inform this research design. Some overlap between how the embedded case studies address these questions is useful for triangulating the data. Sub-question 4d, relating to how the external mentors can be supported is only addressed by the embedded case study of the perspective of recently retired physics teachers and this is highlighted in bold.

By considering these four, the intention is to provide "useful variation" around the research question (Seawright and Gerring, 2008, p. 296) so that the multiple perspectives reveal more information.

3.3 Context and Participants

The context of this study is a higher education provider of teacher education in the Midlands of England. This university prepares around sixty new science teachers each year who study for a one-year post-graduate qualification that also leads to Qualified Teacher Status (QTS). In recent years only a handful of these have been physics subject specialists in line with the national shortage discussed earlier. The university has strong, long-established links with many secondary schools in the West Midlands area and also a vibrant alumni network. In addition, the researcher provides continuous professional development for physics teachers in the local area in the form of regular in-person workshops on topics related to physics pedagogy. These networks are linked to the Institute of Physics and the Ogden Trust and provide access to a wide range of physics teachers in the local area and beyond. For this project, three sets of participants were sought from these populations: physics NQT's in their first year in full time work in schools, post-graduate student teachers of physics at the end of their course about to begin the NQT year and recently retired teachers of physics.

3.4 Phase 1: The Experience of First Year Physics Teachers with No External Mentoring

Three current physics NQT's were recruited to discuss their experiences in the first year of teaching and any experiences of mentoring. These interviews had three aims: to identify issues that the retired external mentors may support the new physics teachers with, to identify significant issues relating to mentoring and explore any links to their intentions for staying in the teaching profession. This was important for the study so that any issues raised could be used to prepare the mentors for their role, inform questions asked to the mentors and mentees taking part in the intervention and so that there could be a comparison of issues between those receiving the external mentoring intervention and those who are not.

The research question that informed this data collection was: What are some of the factors identified by NQT's in physics that influence their decision to leave or stay in the profession during the year post-qualification?

Physics NQT's were sought for this through personal relationships with physics teachers in schools used by the university for teaching placements and from professional development networks previously described. From these teachers known to the researcher, a purposive sample of three were chosen based on their stated intentions about future career. One was set to continue in the profession, one had already left midway through the first year of teaching and the another was planning to leave at the end of the first year. Taking into account the criticism of Thomas (2011) about the generalisability of case study data discussed earlier, my intention in choosing these particular three contrasting situations is that it would lead to different information (Yin, 2009) about the sorts of mentoring these different teachers had experienced and reveal any issues influencing decisions about their future intentions. The different school situations and personal circumstances of the three NQT's helps to address the context specificity limitation raised by Thomas (2011) and adds richness and depth to the account. Any replication between them would be used to inform the design of the planned mentoring intervention.

The interviews were semi-structured to enable full and responsive exploration of the issues emerging and were conducted face-to-face in order to establish trust and rapport (Cohen, Manion and Morrison, 2007). The interview questions are provided in appendix 1 for reference. The questions were designed to address the themes of the research question by asking directly about experiences in school during the first year that are influencing their decision to stay in the profession and allowing space and flexibility to draw out any themes emerging by asking participants to recount specific examples. These interviews lasted between thirty and forty-five minutes and were audio recorded and thematically analysed as described in section 4.10.

3.5 Phase 2: The Mentoring of NQT Physics Teachers

3.5.1 Recruiting Retired Teachers of Physics

To begin the next phase of this project I sought to understand if it was possible to recruit recently retired teachers of physics to mentor NQT's. I did this by advertising in March/April of 2019 for retired physics teachers in three places: university alumni networks, through Ogden Trust and Institute of Physics teacher's networks and by contacting the local University of the 3rd Age branch. Interested potential mentors were invited to respond to the general adverts by making email contact. These potential mentors were then emailed back with more detailed information about the project and asked to respond again if they were still interested in participating. The text of the message is provided in appendix 2 and it can be seen the rationale for the mentoring intervention was explained including brief details of the accompanying study. Any mention of financial compensation for participation was carefully avoided – the project was entirely voluntary in basis. Twelve retired teachers responded to the initial email and were then invited to a face-to-face meeting at the university to find out more about project. Six attended the meeting and five

subsequently agreed to participate in the project. In the meeting which lasted approximately one hour, I explained the project in more detail, invited questions and discussed the ethical implications of the study. The contents of the presentation used are provided in Appendix 3. The retired teachers were asked to further consider their involvement in the project and contact me if they wished to confirm their participation. Of the six attending the presentation, five confirmed and were then invited to a subsequent meeting to meet potential mentees.

3.5.2 Recruiting Early Career Physics Teachers to be Mentored

When trainee physics teachers are near the end of their course at the university there are seminar sessions scheduled to discuss transition to full time work in a school and the expectations of NQT mentoring and development. During the course of these, in June 2019 I took ten minutes to explain the project to the group of six physics trainee teachers asking for them to contact me if they were interested in participating. Being acutely aware of the power dynamic of the relationship with students, as their tutor, I assured them that their participation or not in this project would in no way influence any other aspect of my relationship with them. This call for participation in the study was also scheduled for after students had received final marks for completion of the course to ensure there was no implied penalty for not volunteering. I did not accept students volunteering to join the project straight away but asked them to consider and respond by email later to avoid peer pressure influencing participation. Of the six, three subsequently asked to participate. As there were five recently retired mentors recruited and available, I then widened the possible participation to any of the science trainee teachers in the same way. This resulted in two more interested students, one a chemistry specialist and the other a biology specialist. I then met with this group of five trainee teachers using the same presentation as had been used with the retired mentors (see Appendix 3) to provide further details and allow them the opportunity to ask questions. All five confirmed their

continued enthusiasm and participation after this meeting and so were invited to subsequently meet the retired teacher mentors.

3.5.3 Pairing Mentor with Mentee

Having successfully recruited five retired teachers to be mentors and five beginner teachers to be mentees I organised an afternoon meeting in June 2019 to make introductions, provide some training on mentoring drawing upon the literature reviewed above and formally consider the ethics of the study with all participants. The intention was to pair the mentors and mentees randomly however as two of the mentees were not physics specialists, I deliberately paired them up with mentors with significant expertise in those areas. An important aspect of this meeting was to consider the possible ethical implications of the intervention which is discussed in section 5 and to provide a social forum for the mentoring relationships to begin to become established. With this in mind, plenty of time was allowed for general conversation over refreshments. Methods of communication between mentors and mentees were agreed and contact details exchanged at this meeting. The regularity of contact and the specific agenda for the mentoring conversations was left to be agreed between the individual mentors and mentees and was a focus for investigation during the data collection. Arrangements were made with all mentors and mentees to contact each other at a specific date at the start of the new school autumn term in September 2019 to begin the mentoring. Times were also agreed for semi-structured interviews by telephone to conduct the research into the mentoring with each mentor and mentee in or around the October 2019 half-term school vacation. During the course of the research one of the mentees dropped out of the study leaving four mentor/mentee relationships.

3.5.4 Conducting the Study on Mentoring – Data Collection

Table 2 shows the sub-research questions addressed in phase 2 and the key data collection methods used to answer these questions.

Research Questions	**Data Collection Method**
1. What areas of teacher knowledge are significant for early career teachers of physics and how can these be developed?	Semi-structured interviews with NQT physics teachers.
2. What is the evidence for external mentoring by retired teachers as an effective intervention to support physics teacher retention and teacher knowledge growth for early career physics teachers?	Semi-structured interviews with NQT physics teachers.
3. What are the ways and extent that informal mentoring of physics NQT's can be facilitated by recently retired teachers of physics?	
a. What are the specific contents of mentoring conversations between physics NQT's and recently retired physics teacher mentors?	Semi-structured interviews with NQT physics teachers and recently retired physics teacher mentors. Focus group discussion with recently retired physics teacher mentors.
b. To what extent does the contents of the mentoring address known knowledge bases of teachers and promote teacher growth?	Semi-structured interviews with NQT physics teachers and recently retired physics teacher mentors.

	Focus group discussion with recently retired physics teacher mentors.
c. What are some of the limitations and challenges of this type of informal mentoring?	Semi-structured interviews with recently retired physics teacher mentors. Focus group discussion with recently retired physics teacher mentors. Email correspondence with mentors and mentees.

Table 2 Data collection methods in phase 2 of the project

3.5.6 Semi-Structured Interviews

Three data collection points were used to obtain qualitative data by semi-structured telephone interview with all the ten participants. These were planned to be October 2019, February 2020 and June 2020. All phone interviews were audio recorded and lasted between 15 and 30 minutes. The data was thematically analysed as described in section 4.10. The consequences of Covid-19 on schools led to the abandonment of the last data collection point in June 2020 leaving two sets of interview data and twenty interviews. Whilst not providing what would have been useful data on the intentions of the early career physics teachers at the end of the academic year, the extraordinary circumstances in which schools were operating at this time may have given rise to data in such a specific context that it might have further limited any explanatory usefulness of the findings.

Semi-structured interview was chosen as a data collection method as it allows responses to collected about “complex and deep issues” (Cohen, Manion and Morrison, 2007, p. 349) where mentoring, a topic of mutual interest of the researcher and participants, could be discussed in a flexible way. In answering the research questions that seek to explore the contents of mentoring discussions and the intentions of participants, issues would be raised that would be hard to anticipate in advance. Therefore, these interviews were administered by preparing a list of questions to be asked that elicited open responses by the participants where themes raised could be developed during the interviews (Brown and Danaher, 2019). This was also a reason to choose to use semi-structured interview in preference to other data collection methods such as questionnaires. Another was to enable some element of “multi-sensory” (Cohen, Manion and Morrison, 2007, p. 349) data to be collected where possible over the telephone for example tone of voice and use of pauses. The limitations of the phone interview described by Arksey and Knight (1999); being deprived of some channels of communication which would be present in person and the difficulty of establishing a positive relationship are acknowledged. The first of these was judged to be less significant than using an alternative means of data collection such as a survey discussed above. The second of these was addressed by meeting in person first at the start of the study to establish the relationship before continuing by telephone. The advantage of using the telephone interview in this study was that it allowed the researcher to select the participants from a geographically diverse region as some of the new teachers were moving to take up their first posts and enabled interviews to take place at times and locations convenient in the busy lives of the participants. These interviews also took place before the widespread adoption of video calling became normal in the wake of Covid-19 lockdown and so was not considered an option for data collection.

The questions asked during the interviews and how they relate to the research questions are shown in table 3.

Research Questions	Interview Questions
2. What areas of teacher knowledge are significant for early career teachers of physics and how can these be developed?	What are the contents of the discussions you have had with your mentor / mentee?
3. What is the evidence for external mentoring by retired teachers as an effective intervention to support physics teacher retention and teacher knowledge growth for early career physics teachers?	How many times and in what ways have you been in contact with your mentor/mentee? Are you currently intending to continue teaching next academic year? And in 5 years? What factors are influencing your thinking about whether you will stay in teaching?
4. What are the ways and extent that informal mentoring of physics NQT's can be facilitated by recently retired teachers of physics?	
a. What are the specific contents of mentoring conversations between physics NQT's and recently retired physics teacher mentors?	What are the contents of the discussions you have had with your mentor / mentee? Can you give a specific example of a conversation you have had?

b. To what extent does the contents of the mentoring address known knowledge bases of teachers and promote teacher growth?	Have you sought/given guidance about any of the following topics? - Subject knowledge - General pedagogy - Subject specific pedagogy
c. What are some of the limitations and challenges of this type of informal mentoring?	Are there any ways that this type of mentoring could be better facilitated?

Table 3 Semi-structured Interview questions and how they relate to the research questions

3.5.7 Focus Group of Mentors

In addition, an in-person unstructured focus group for the 5 mentors lasting for an hour was scheduled for February 2020 where a general discussion about the mentoring project was facilitated by the researcher in order discover the collective perspective of the group (Gibbs, 2012) and to allow relevant themes to emerge (Silverman, 2006). I chose this methodology in addition to the telephone interviews because of the benefits to the participants. When first meeting, the mentors had expressed enjoyment in discussing their experiences together and asked to be able to meet as a group again. This positive group dynamic may benefit the study by allowing each participant to feel empowered to talk in a way they would not if on their own (Gibbs, 2012). During the focus group, data was collected by taking field notes, noting key points made by the participants and some verbatim comments during the free-flowing conversation. Field notes were chosen as a complementary data source to audio recordings of interviews which allow the researcher to additionally record their own "impressions, emotions and contextual details" (Tessier, 2012, p. 457).

3.5.8 Email Correspondence

Contact was made between the researcher and participants by email at multiple times between these data collection points and information from these was also used to triangulate data from the interviews and focus group for example with relation to how often the mentors and mentees made contact with one another. This was important in providing data to address research question 4c around the limitations and challenges of the mentoring intervention, which may include information around the frequency and methods of contact between mentors and mentees.

3.6 Analysis of Data

In order to ensure all the data supplied by the participants was captured and analysed a summary grid based on the research questions was used to combine the responses of all the participants into a whole where emerging themes could be identified (see Table 4). An example of a completed grid is given in Appendix 4. Specific quotations identified as being revealing were also noted verbatim in this process. Similarly, from field notes of the focus groups and email records, key themes were identified and compiled using the same grid format alongside the research questions. From these themes it was possible to combine the participants data into four units of analysis which preserve anonymity and describe the lived experience of these teachers and mentors in detail. These units of analysis address the case and research question on the efficacy of mentoring of early career physics teachers in the first year of teaching by recently retired physics teachers and the impact on retention. The four sub-units of analysis that will be presented are: physics teachers in the first year of their careers with no external mentoring, first year physics teachers who are engaging in mentoring by a retired physics teacher, first year physics teachers who are experiencing challenges engaging with mentoring by a recently retired physics teacher and the perspective of the recently

retired physics teacher mentors. These have been chosen to elucidate the data relating to the research questions allowing in-depth understanding and at the same time enabling cross comparison of the units of analysis that will allow an analysis to reveal useful insights (Day Ashley, 2012).

Research Question	Participant A	Participant B	Participant C	Summary and Key themes
Example Q 1				
…				

Table 4 Example of Data Analysis Grid

3.7 Limiting Researcher Bias

As the researcher studying this mentoring intervention and also the teacher educator implementing the intervention, I am aware of the possibility of researcher bias in this case study, particularly the temptation to "substantiate a preconceived position" (Yin, 2009, p. 61). In order to address this and make the findings more robust, Yin (2009, p. 62) suggests that it is important for the researcher to test the degree to which the researcher is open to contrary findings by reporting "preliminary findings – possibly while still in the data collection phase – to two or three critical colleagues". The idea being that these colleagues would offer alternative explanations or suggestions for data collection or interpretation. I attempted to do this by presenting initial findings at an internal education research conference at my higher education institution in June 2020, noting down questions and challenges from academic colleagues and incorporating these ideas into the study.

4. Ethical Considerations

The ethical considerations that guided this research will now be discussed. This study was planned and completed following approval from CUREC and following the British Educational Research Association (BERA) guidelines (BERA, 2018) particularly with regard to the consent, privacy and well-being of the participants. The ethical considerations fall into two parts which are described below: the ethics of mentoring and the ethics of the research study.

4.1 The Ethics of Mentoring

This mentoring intervention voluntarily recruited two groups; beginner physics teachers at the end of their training and just prior to starting their first jobs and also recently retired physics teachers. The two groups did not know each other prior to the intervention. The first group, the beginner physics teachers, were recruited from the cohort of students that I had tutored during the academic year. This raised questions about whether they might feel obliged to take part because of the power relationship between myself and them. I addressed this in a number of ways. Firstly, I did not introduce the prospect of the mentoring until after the assessment elements of the course were completed and the student teachers had received their marks as well as their final grade for the course (subject to examination board). This attempted to remove the implication that participation or not might somehow affect academic or professional achievement. When informing the student teachers about the project I also did so when they were assembled in groups so as to avoid inadvertently pressuring individuals to respond in a personal conversation where they might wish to elicit a positive response from myself as their tutor. The students were clearly informed about the rationale and aims of the study and its relation to the researcher's academic work. Potential participants were asked to indicate their interest by email and then attend a meeting with the potential mentors. Similarly, the retired teachers were recruited voluntarily and given opportunity to

find out about the research before committing to taking part. When the two groups were introduced some of the ethical issues around mentoring were explored in depth. These included:

- The right of mentor or mentee to cease participation at any time for any reason.
- The right of mentor and mentee to control their personal information by specifying how they wished to be contacted and when and what to share with the mentor/mentee. For example, if the contact was to be by email only then to not share phone number or address. This was to be agreed between the mentor and mentee.
- What to do if either party had any concerns about the behaviour of the other party in the mentoring relationship. This included considering how to act if there was a concern for the physical or mental wellbeing of the other, or if a safeguarding issue arose. In these cases, the procedure was to contact the researcher who would take reasonable action including referral to specialist agencies where required. Mentors and mentees were assured that they were in no way responsible for these situations and should report them if they arose.
- How records of mentoring conversations would be stored by the mentor/mentee. For example, if they were happy for the other party to make written or electronic notes and keep these for reference or not and how they would be stored. This was to be agreed between mentor and mentee.
- The confidentiality of the information discussed in mentoring conversations. Both parties were informed about the potentially private nature of comments about individual pupils, schools or other teachers that would be made in the context of mentoring. They agreed to keep these details confidential to avoid reputational damage, safeguarding issues or embarrassment of participants.
- The duration of the project was set for one academic year with a minimum expectation of contact between mentor and mentee of once per term. This was to ensure all parties were aware and content with the commitment they were making.

4.2 The Ethics of the Study

In conducting this study, there are significant ethical issues around the storage and use of data from the participants which may contain personal information or identifiable data about particular schools or individual students in those schools. Participants were assured of their anonymity and this was accomplished by referring to them by pseudonym in the study. In order to address the safeguarding issues referred to above it was necessary to keep and store electronic records of real names and contact details of all the participants for the duration of the study. These were kept in a spreadsheet stored on an encrypted university owned password protected laptop with the permission of the participants. The data collected was in the form of individual recorded audio conversations, audio of group conversations and notes made on paper in a notebook. All of this data was also digitised and transferred to the university owned laptop where it was stored, backed up, password protected and encrypted. Physical copies of notes were stored in a locked filing cabinet in the home office of the researcher. In these notes the pseudonyms of the participants were used. The participants were also made aware that they were able to cease participation in the study at any time for any reason – even if they wished to continue with the mentoring. Participants were made aware and asked to agree to the researcher contacting them at three points during the year for a phone conversation lasting approximately 30 minutes exploring the research questions of the study. The mentors were additionally asked to attend an in-person focus group midway through the study. This defined the minimum time commitments for the project. All participants were given a participant information sheet and agreed to and signed the ethical consent forms (see blank example in Appendix 5) which were stored in a locked filing cabinet in the home office of the researcher. All physical and electronic data would be kept only for the duration of the study (one year) and then destroyed securely by shredding paper and using secure delete electronic tools. Participants were informed of their right to access to any data provided by them or about them.

5. Research Findings

The case or unit of analysis is focussed on the efficacy of mentoring by retired physics teachers and its ability to support NQT's to develop their practice and better ensure their retention in the profession. To address this the findings are presented as embedded cases, in four sections to present a range of perspectives on the external mentoring in order to answer the key research questions. A summary of how these embedded cases address the research questions is provided in table 1 above. Each section presents a narrative of the perspectives of the participants drawing on quotations to support these perspectives. At the end of each section the key themes are analysed in relation to how they address the research questions and link to the key literature. The four sections are:

- Physics teachers in the first year of their careers with no external mentoring, in order to obtain insights into the issues the retired teachers may need to support.
- First year physics teachers who are engaging in mentoring by a retired physics teacher. This section presents the similar perspectives of two NQT's who had a positive experience of the external mentoring.
- First year physics teachers who are experiencing challenges engaging with mentoring by a recently retired physics teacher. This section presents the perspective of two NQT's where the external mentoring was less successful.
- The perspective of recently retired physics teacher mentors.

5.1 Physics Teachers in the First Year of Their Careers with No External Mentoring

This section addresses research question one: what are some of the factors identified by NQT's in physics that influence their decision to leave or stay in the profession during the year post-qualification?

Michelle, Yvonne and Roger are all full-time physics teachers in their first year of teaching at schools in the West Midlands of England. Each of them describes different feelings on their future in the profession.

5.1.1 Michelle

For Michelle the decision was made quickly. Mid-way through the first half term of the year she had started to have doubts when faced with difficulties managing student behaviour and in meeting school management expectations of workload – she cites for example the need to mark all students books comprehensively every three weeks. She approached her school line manager to discuss these problems and said "I don't think it is right for me here..and I don't see myself pulling it back. I can only see this getting worse." The school responded supportively, and her experience improved for a short time but by the end of term and considering forthcoming NQT assessments she decided to hand in her notice. By the time of the data collection a few months later and able to reflect with some distance on these events Michelle indicated that with hindsight it had been a bad decision to start work at that school. She said it was one of her placement schools from her initial teacher education and that the school "made it very very easy to apply, you know attach a covering letter to a CV basically". This influenced her to take the job. Michelle was not the only physics teacher in the school, her in-school mentor was also a physics teacher but she said that "I don't think any amount of support could have fixed properly underlying problems, which were with the school". She describes meetings with her mentor as mainly discussing NQT targets, issues after lesson

observations and school administration. Tellingly she reflects that “I love teaching. I just didn’t like being a teacher.” Michelle has a PhD in Physics and was quickly able to establish her own business after leaving teaching.

5.1.2 Yvonne

Yvonne came to teaching later in life after a successful career as an engineer. Her experience of mentoring in school was different to that of Michelle. It was jointly delivered by a subject specialist physics teacher and the head of the science department. Issues such as safeguarding, lesson planning and marking were dealt with in a systematic way and the specialist physics mentor encouraged the asking of questions. However, Yvonne did not always feel able to ask about what she felt were the most significant issues with either of the mentors:

> “I think they are usually really busy”, “I certainly feel like I could approach my mentor. So it’s not the fact that I don’t feel like she’s supported me in that. It’s more just the fact that I prefer talking to an equal”.

Yvonne describes some particular difficulties with workload mid-way though the NQT year:

> “I think really, it was the planning. And then the marking then, was kind of the straw that was breaking the camel’s back.”

She also then recounts a positive experience where her mentor understands her needs and supports her by giving advice on how to cut back on the planning of lessons and allowing her some leeway with the schools marking policy. This whole situation however, causes Yvonne to reflect on her decision to be a physics teacher,

> “What I do know is that working full time in teaching, as it is at the moment, is not working out for me, which is my reason for deciding to leave. It’s a work life balance thing really. I think

> if I could find a way to carry on teaching, but, basically, giving me more time to do the things that I want to do then I think I would like to carry on teaching".

Yvonne left teaching after successfully completing her NQT year to return to employment as an engineer.

5.1.3 Roger

Roger on the other hand, despite facing some similar challenges to Michelle and Yvonne in terms of managing student behaviour is planning to stay on as a teacher. He says, "It's quite a challenging school in terms of behaviour. I don't actually do that much teaching with some of my groups." Roger has found support from heads of faculty in school in dealing with this, but not from his appointed NQT mentor, "He's very busy and he rarely sees me". He goes on to explain:

> "It's not really like the training course which was really nice, you got loads of advice, loads of support. You feel like you're guided. Now you do feel like, at the end of the day they don't want the stress of talking, they've got their other issues to deal with."

Roger is the only specialist physics teacher in his school and sometimes feels like he does not have the background knowledge he needs due to not having a physics degree "I know one module well..but I just don't know much about that electricity and magnetism". Roger has found that other teachers in his school help him informally with his subject knowledge and with emotional support to help him keep going. Describing a colleague, he says "He's just a nice guy, he's an experienced teacher and he comes and helps me all the time." This colleague "has loads of experience. If it wasn't for him I reckon I would have been so much more stressed." Roger clearly feels like he is making a difference to the children he is teaching. When asked about his plans for the future he immediately explains that,

> "there's been days when I've definitely wanted to quit but I've gotten through it and I do love that feeling when a student really appreciates your presence and that is the best part of it easily….I want to teach that's always been my one thing."

Roger stayed at the same school for the next academic year.

5.1.4 Summary and Discussion of Emerging Themes

From this data, some factors expressed by this small sample of new physics teachers influencing their decision to leave or stay in the profession are:

- Managing student behaviour
- Workload
- Availability of alternative career options
- School culture
- Availability of informal support from colleagues.

These themes directly address the first research question and are familiar – all have been discussed to some extent earlier in the literature review. Michelle and Roger both mention managing student behaviour as a difficulty in their first year which agrees with many other findings (Locke, 1993; Barmby, 2006; Gonzalez, Brown and Slate, 2008) and both received support in dealing with this but in contrasting ways. For Michelle it came through the intervention of the appointed school NQT mentor which in this case turned out to be unsuccessful in providing the right support. For Roger the decisive support came in an informal way through the actions of a more experienced and older colleague rather than the NQT mentor who he felt was too busy to approach. This supports the conclusions of Luft (2009, p. 2380) referred to earlier about the importance of the empathetic, available "teacher next door" and themes around the importance of supportive working conditions raised by Weiss (1999) and Sims (2019). Michelle and Yvonne shared workload concerns also found

in the literature (Barmby, 2006), with Yvonne this time voicing reticence about approaching an NQT mentor for support who may be too busy to help. Michelle seems to be focused on the conditions and culture of the school itself, a factor also written about by Dupriez, Delvaux and Lothaire (2016) and Weiss (1999). Ideas in the literature about teaching as a transitional phase in a career (Smethem, 2007), the mobility of teachers in the first year post-qualification (Sibieta, 2020) and the employability of physics graduates who can easily move on to other lucrative jobs (Sibieta, 2020) is sadly exemplified in both the cases of Michelle and Yvonne. Would their retention outcomes have been different if they had experienced the kind of informal support available to Roger? This question exposes the heart of this study, forms the overarching research question and the idea for it's design.

5.2 First Year Physics Teachers Who Are Engaging in Mentoring by a Retired Physics Teacher

This section presents the findings from Brian and Rita who had a similar positive experience of working with an external retired physics teacher mentor.

5.2.1 Bryan

Bryan has been in touch with his retired physics teacher mentor twice in the first term since starting his new job. He initiated contact with his mentor, John, by email to ask advice on setting up new routines with his classes. John responded by arranging to phone Bryan at an agreed time and they spent around 30 minutes talking. In this conversation John first asked about each of Bryan's classes in turn and they discussed specific issues for each. For example, in a y8 class Bryan felt to have a "wide range of abilities" where Bryan was concerned about being able to cope, John provided some reassurance to Bryan and suggested some different types of activities that may be suitable for different children. Bryan was also concerned about an upcoming observed lesson from his in-school

mentor that was going to contribute to his NQT assessment. The lesson was about waves, a topic Bryan had not taught during his training year. John was able to draw upon his own classroom experience to suggest a simple practical activity involving using a long length of rubber tubing to demonstrate wave motion that Bryan implemented in his lesson with great success. Bryan was also a little confused by some of the school documentation he had been given at the start of term – policy documents and information about school routines. Bryan went through some of these over the phone with John who was able to explain what some of the language meant and how Bryan should be implementing them in his context. These last two issues were ones which Bryan did not feel able to talk about with his in-school mentor as he found that those NQT mentor meetings were "more of a checking up on me". Speaking of the external mentoring at the first data collection point, Bryan commented "I think it's been more useful than I thought it would be, in terms of its like having an extra opinion on things" and he also said "It's good for running ideas past someone for reassurance or confirmation". After the phone conversation, John sent Bryan an email with a summary of what they had talked about and attached some useful resources for Bryan to use.

By the time the second data collection point arrived three months later Bryan reports that he and John had established a routine,

> "Every three weeks we have the same conversation. And that's usually about half an hour. After that John will email and send through the minutes and anything I have asked him for."

In terms of what they talk about,

> "generally it's just kind of, how I've been doing, if there's any problems. Usually he (John) follows up on something we talked about the last time."

When asked about specifics, Bryan thought of an example relating to one of his year 10 classes where he wanted to challenge the pupils with questions on the topic of electricity and magnetism. John "suggested a sort of plenary of categorising things" where questions that arose during the

lesson would be written down and put into boxes to be reviewed at the end of the lesson. Bryan felt this activity worked well with his class. Bryan also valued John's opinion on pedagogical strategies being introduced in his school. For example, he mentioned "live marking" where Bryan was being encouraged to mark students' books during lessons as he circulated. John suggested obtaining a 'verbal feedback given' stamp and then asking the students to write down what Bryan had just discussed with them. Bryan found this extra input helpful. Referring to the live marking advice he said "So, he was just giving me little tips in how I can show that, without it being flimsy." Bryan was asked how he was benefitting from the external mentoring. He compared it to his in school NQT mentor in the following way;

> "It's more individual, John will just literally say, how's this going? How's this gone?..because at school they know I'm ok with the day-to-day stuff so they won't go over it again."

Bryan is intending to stay in teaching at the same school.

5.2.2 Rita

Rita is a new chemistry teacher, involved in the external mentoring program after it was offered to physics teachers. Her data is included briefly here as it is interesting to note similarities to the experiences of Bryan. She is paired with Bernard; a retired chemistry teacher. Rita and Bernard were in touch five times in the first term by email but not by phone. Rita explains this was because life has "just been a bit hectic". Similar to Bryan, she too has sought general advice on how to get classes to engage with their work, in particular she admits to relying on using PowerPoint for her lessons too much and Bernard has been advising her on how to use the whiteboard and pen more. Rita comments that it is:

> "nice to have the back-up of the retired mentor – they are another teacher to ask just in case. Sometimes my school mentor is assessing me and I am relieved there is someone else I can ask for advice."

By data collection point 2, Rita and Bernard had still not spoken on the phone but were keeping in touch regularly by email. Rita had raised the issue of how to manage workload with Bernard

> "Well I didn't really want to bother them (in-school NQT mentor) too much because there's that sort of aspect of they're actually assessing me and stuff."

Rita also asked about classroom management,

> "I did actually reach out and ask for a bit of advice on how to redeem classes when I let behaviour slip of bit because of tiredness and that."

She had in fact already asked her in school mentors for support but after having done this once she was concerned not to bother them further, "it was a bit like, well, I don't really want to continue saying 'oh this is a problem'".

Rita is also intending to stay at her school for the next academic year.

5.2.2 Summary and Discussion of Emerging Themes

Some of the themes arising from the data from teachers who engaged with the external mentoring by retired teachers are:

- The significance of having someone to refer to with an external perspective from outside the immediate school environment.
- The mode of communication for effective mentoring can be varied.
- External mentors are able to offer support with general pedagogy (for example classroom management), and subject specific pedagogy.

- External mentors can provide different kinds of support due to them not being involved in NQT assessment.

These themes directly address research questions 4a and 4b by revealing the types of issues that are the subjects of conversation between these beginner teachers and their retired mentors and how these relate to known teacher knowledge bases. In the model of physics teacher knowledge suggested by Etkina (2010) in figure 4 the knowledge of questioning and assessment sought by Bryan could be thought of as pedagogical knowledge situated in the particular context of his school with its practices and rules that Bryan is seeking to combine with his physics knowledge to grow in PCK (Shulman, 1987). Bryan also asks John directly about his "knowledge of effective instructional strategies" (Etkina, 2010, p. 2) and John describes a demonstration to teach waves from his own context and experience. There does not seem to be evidence of the articulation of pedagogical reasoning behind the choice of activity John shares with Bryan that would for Kind (2009) indicate the influence of an expert teacher instructing a novice however this sharing could be argued to provide Bryan with a means of comparing his own practice to that of other contexts which as suggested earlier by Lave and Wenger (1991) enables a teacher to accelerate their own development as they participate in what has become a community of practice. The availability of the external mentor in contrast to what she perceives as the busyness of teachers in her own school is highlighted by Rita which echoes the findings of Luft (2009, p. 2380) that it is the "teacher next door" who can contribute most to this participation in a learning community.

Both Rita and Bryan hint at the potentially conflicting dual role of the NQT mentor in school who must be both a supporter and an assessor, lending weight to the earlier similar suggestions by Willams and Prestage (2002) and potentially challenging current formal mentoring practice for NQT's in schools in England.

Interestingly these two interactions between mentors and mentees who are engaged in the process by communicating regularly there is not one mode of communication favoured. The more irregular

email-at-need communication of Rita and Bernard seems to provide benefits as much as the well organised, scheduled mixed mode of phone call followed by email summary of Bryan and John. This suggests that these types of mentoring relationships work well when availability and communication style of mentor and mentee are aligned rather than prescribed externally.

There is also a sense running through Bryan's comments of himself as an improving teacher who is seeking confirmation from the mentor as a more experienced advisor, and of his continued enthusiasm for being a physics teacher. This supports earlier similar findings of Rushton and Criswell (2015) and Pogodzinsji, Youngs and Frank (2013) and suggests that the external mentor may be supporting Bryan's feelings of connectedness that mitigate against the isolation that can lead to some teachers leaving the profession (Tye and Tye, 1984; Hiller, de Winter and Twidle, 2013; Gilbert, 2011). Some of the same positive impact is seen in this data as found by Hobson *et al.* (2012) in the evaluation of the earlier SPN project described earlier; reassurance, increased confidence, independence of mentor from school and credibility of mentor.

Positive impact on retention is cautiously noted as both Bryan and Rita intend to continue in the profession.

5.3 First Year Physics Teachers Experiencing Challenges Engaging with a Retired Physics Teacher Mentor

In this section the findings from Charlie and Matt are presented who both of whom had a similar more problematic experience of working with an external retired physics teacher mentor.

5.3.1 Charlie

Charlie has started a job in a large school where she is not the only physics teacher. She emailed her external mentor, Greg, three times within the first few weeks to ask questions about managing pupil behaviour and how to challenge more able pupils. Greg replied with what Charlie perceived as useful advice and Charlie contrasted the kinds of support she sought from Greg with that provided by her in school NQT mentor:

"My school mentor asked more admin questions, 'Am I doing this right?' 'Am I meeting the teaching standards?' I could ask Greg more about the subject teaching".

Charlie also found other colleagues in the school very willing to offer her help in context such as inviting her to observe some classes she taught with other teachers. Charlie wishes she had more support however and expressed some self-doubt "I don't know if what I am doing is good enough". At the first data collection point she was unsure if teaching was the right career choice for her,

> "I was enjoying it but it got stressful..I am worried about losing my enthusiasm. I don't know if I intend to stay in teaching. If I get A level physics teaching next year then I am more likely to stay".

By the second data collection point the situation had changed for Charlie and she seemed much happier. She was now definitely planning to stay on at the same school. Her school had started subject based continuous professional development sessions every 2 weeks which she was finding very helpful and so she had less contact with her external mentor. She comments that he, "would be

useful if I had not got so much support in school". Greg by this time was finding it hard to get email responses from Charlie but still persevered asking regularly how she was doing by email.

5.3.2 Matt

Matt found it hard to get in touch with his external mentor, Harry from the outset. Within the first few days of starting his new job in a small secondary school, he sent an email to Harry asking a few questions (he could not remember exactly what) but when Harry did not get back to him straight away found that he got the support he needed from colleagues in his department. The main issue Matt reported was that in his school "lots of people are focussed on the perception among pupils that physics is hard and so don't try". He received lots of advice from colleagues on how to deal with this but was still left with other questions around school life and organisation that he did not feel as confident about. Matt reported having questions such as,

> "How often do I mark? How do I deal with required practicals at GCSE? How do I do end of unit tests? How do I give feedback to pupils?".

Despite these questions Matt made no further attempt to contact his external mentor as he found his two other colleagues in the small science department very available, commenting that, "there is lots of facetime". From these colleagues, Matt was able to obtain the support and advice he needed specific to his school context. From Harry's perspective he would have been happy to be consulted a bit more and was to some extent disappointed not to be. He said: "my point of view could be beefed up a bit". He reported getting an email back from Matt saying he did not have any problems or questions. By the second data collection point further contact had been attempted but again Matt reported difficulty engaging with it,

> "whatever we were talking about must have died out because it obviously wasn't gripping enough or I didn't need much attention."

Matt is not currently planning to continue as a physics teacher after the end of his NQT year and hopes to be able to go travelling before deciding what to do next.

5.3.3 Summary of Emerging Themes

Some of the themes arising from the data from teachers who experienced challenges engaging with external mentoring are:

- Support from within the context of the school can be more targeted and useful than from external sources.
- Good subject based professional development in school to some extent removes the need for external mentoring.
- Prompt response to questions improves the relationship between mentor and mentee.

These themes also directly address research questions 4a and 4b but also reveal some of the challenges and limitations with this type of mentoring which are the subject of research question 4c. Indications of intentions to continue in physics teaching, research question 5, are also touched upon.

The contents of these conversations were more limited, stymied by problems of communication with the external mentor and lack of perceived need due to the availability of support within the school. Matt and Charlie still had questions that would broadly fall under Etkina's (2010) categories of PCK and pedagogical knowledge but felt them to be addressed within the school eventually even if not initially in Charlie's case. There is no evidence from these new teachers of the specific problems relating to physics identified by Childs and McNicholl (2007) of teaching outside subject specialism nor of the lack of opportunity to learn informally identified by Hiller, de Winter and Twidle (2013). There is on the other hand some evidence to suggest that Matt and Charlie experienced something of a community of practice (Lave and Wenger, 1991) with available colleagues providing the timely (Williams and Prestage, 2002), empathetic (Luft, 2009) and physics

subject specific support (Cameron and Grant, 2017) required. For Matt based in a small school department and not intending to continue as a physics teacher there are hints of disengagement which resonates with the findings of Gilbert (2011) that some new science teachers see entry to the profession as a transition to something else (in this case nothing is yet specified) and therefore may raise some questions about how fulfilled he feels in the role (Rushton and Criswell, 2015) and his ability to "make a positive difference" (Chiong, Menzies and Parameshwaran, 2017, p. 1104). The context specific nature of teacher knowledge identified by Hodson and Barnett (2000) is prevalent in the comments of both Matt and Charlie

5.4 The Perspective of Recently Retired Physics Teacher Mentors

This data is combined from individual interviews and focus group discussion with the retired mentors and allows an element of triangulation and comparison with the views of the mentees, as well as offering insight into specific ways that these mentors might be supported in their roles.

5.4.1 John, Bernard, Greg and Harry

All the four mentors ultimately involved in the project were male, and reported enjoying the mentoring experience in different degrees and all had suggestions for how to improve it. John and Bernard, both feeling that their NQT mentees were engaged in the process both said they were happy in the role. Bernard reported being consulted more on general pedagogy, not so much on subject specific ideas or subject knowledge but behaviour management and marking – both topics on which he felt able to offer advice and specifically, reassurance about how normal it was for a new teacher to be experiencing challenges in these areas. John took a very organised approach to the phone calls he and his mentee shared and his questioning about each individual class led to more

discussions about subject specific pedagogy. John was particularly pleased when in subsequent phone calls it was clear that Bryan had acted on his advice and it had obviously been helpful. This form of feedback only occurred in Bryan and John's relationship however – the other mentors reported that it was hard to know whether the mentees had acted on any advice they had given particularly of the kind where they had suggested classroom activities and were eager to know how the ideas had worked. There was some discussion about the timing of these requests to help with lesson planning lesson activities – often occurring at short notice, just before assessed lesson observations for the mentees. None of the mentors reported any questions or discussions relating to subject knowledge and questioned whether that sort of knowledge acquisition was suited to mentoring relationships. Greg and Harry both reported that their mentees seemed very confident and were difficult to contact, despite agreeing ways and times for doing this prior to term starting. They both questioned whether email is a good tool for this type of relationship and found it frustrating when they tried to make contact but the mentee did not reply – John suggested using email primarily as a tool for making phone appointments and for sending resources rather than attempting to have conversations. There was a set of suggestions for improvements to the program that reflected how positive the mentors were to make a difference and do more for the mentees. Ideas such as: visiting the mentees in their schools, conducting lesson observations, having a more organised and fixed timetable for conversations. Reflecting on these in the group discussion however it was raised that all of these things would make the external mentoring more like what already occurred in school and would make them "part of the system" which may affect the type of relationship they could establish with the mentees.

5.4.2 Summary of Emerging Themes

Some of the themes arising from the data from external recently retired teacher mentors are:

- The enjoyment and fulfilment of the retired teachers in the role of mentor.
- Questions of the extent to which the mentoring should be more organised or more informal.
- The focus of advice given being on general pedagogy with some physics PCK.
- Questions about the most effective ways of communicating with NQT teachers.
- The desire for some feedback from the mentees on the impact of support given.

These themes directly address research question 4 and in particular question 4d which is how can recently retired teachers be supported as mentors? The similarity in the enthusiasm expressed by John, Bernard, Greg and Harry for the role of mentor to that reported by the retired teacher mentors in Gold's (1987) earlier similar study is notable. In fact, all four of the mentors would have liked to be more involved with the mentees and expressed confidence in their own knowledge and experience that they could contribute (Alvy, 2005). The main types of support that the new teachers drew upon the retired mentors to provide was in the areas of PCK and general pedagogy which challenges the finding of Hobson *et al.* (2012) about the Stimulating Physics Network project where one of the outcomes was identified as increased confidence in the subject knowledge of physics. The other themes emerging from this data which add to knowledge about this type of mentoring are the questions raised about effective communication between mentor and mentee and the ways in which mentees reported acting on the advice of mentors. In terms of communication, no one way was shown to be more useful than any other with email, phone call and text message being used. The most successful practice in these data involved regularity and combination, with the freer flowing relationship building conversation of phone calls then summarised into email text and a schedule for communication agreed and adhered to. The positive effects of feedback to the mentors from mentees also seem to contribute to the successful relationships allowing mutual trust, respect, and satisfaction to develop in line with the working definitions of mentoring suggested by Parsloe

(1992) and Clutterbuck (2001). Without this relational reciprocity the mentoring seemed to be less effective. This would suggest that building in a loose structure to mentoring conversations, reviewing how discussions from the previous mentoring conversation have progressed might have positive impact on both mentor and mentee. This noting the caution expressed by the mentors in becoming too formal and so too closely imitating school-based procedures.

6. Implications

This final section explores the extent to which the findings address the research questions and evaluates the methodology used. I will argue that useful information has been uncovered about the physics teacher knowledge growth that can be facilitated through informal mentoring, but more data is required if the impact of mentoring by recently retired physics teachers on retention is to be addressed. I end by considering implications for my own practice as a teacher educator and with proposals for further research.

6.1 Addressing the Research Question

This project investigated the following research question: What is the extent to which informal mentoring from recently retired teachers of science can support beginner teachers of physics to grow in their teacher knowledge and influence their retention in teaching?

Understanding the lived experience of beginner physics teachers in the first-year post-qualification through the first phase of this study showed that the factors influencing their retention in the profession have been well understood in previous research. The emerging theme from this that informed the mentoring intervention was around the importance and availability of informal support from colleagues. Several previously mentioned studies attach significance to the way that available, subject-specific and empathetic support can contribute to addressing some of the problems new physics teachers face, for example feelings of isolation and of not being able to make a difference. The areas of teacher knowledge most sought by the teachers in this study were PCK and general pedagogy (with behaviour management mentioned most frequently) – again supporting previous findings in the literature. Some of the new physics teachers studied found this support to be available in their school from sympathetic colleagues but not all – and where it was not, the additional input by the retired teacher mentor was welcomed. In school informal support where

available had the advantages of being context specific, immediately applicable and was perceived as useful. There is also some evidence however that indicates that an experienced external perspective has different benefits, for example in the opportunity to critically reflect on school policy, discuss potentially professionally embarrassing issues relating to behaviour management and obtain advice about NQT assessments with someone independent of the process. In terms of teacher knowledge growth then, this study would suggest that informal mentoring can be significant in developing the PCK and knowledge of general pedagogy of first year physics teachers, whether it happens internally within a school or externally by the retired teacher mentors. It further indicates that this informal support does not always happen and where it does not, opportunities are potentially missed for this teacher knowledge growth. Where there is more uncertainty is on the impact of informal mentoring on physics teacher retention. Of the four new physics teachers taking part in this small-scale intervention, three are continuing in the profession with one leaving.

Of additional note is the ease at which it was possible to recruit retired physics teacher mentors and their enthusiasm and willingness to make themselves available flexibly to mentor the new teachers and also their desire to go on contributing to education in retirement. The retired teachers were willing to do this without payment. This suggests that a larger scale similar project could be both feasible and good value for money.

6.2 Evaluation of Methodology and Suggested Improvements

Detail and richness has been provided in the case study data in the hope that the description and analysis of the particular case may suggest implications that can be drawn out in the context of the interested reader and hint at generalisations (Yin, 2009). A limitation of this case study methodology is that the interactions between mentor and mentee are subject to the individual personalities of the participants and their own contexts. The suitability of the mentors for the role they were asked to take on was in this project ascertained by the researcher informally and by discussion at the

preparation meetings and training. No attempt was made to assess mentoring skills which may impact upon the effectiveness of the project. A more extensive program of training in mentoring skills with a more structured approach to the mentoring conversations would seem like a sensible step to investigate in a future iteration of this intervention. Obtaining data more frequently than once per term may also support enquiry into the contents of the conversations as more time elapsed may have resulted in participants not being able to remember details accurately.

The methodology of semi-structured telephone interview could be replaced by using video calls as these have become mainstream in the months of the Covid-19 pandemic. This would enable some of the criticism of telephone interviews raised by Arksey and Knight (1999) to be addressed by allowing more non-verbal communication and promote relationship building. This may also help the mentoring conversations as well as the collection of valid data.

6.3 Implications for Teacher Educators

The study suggests that it is potentially productive for teacher educators involved in physics initial teacher education to consider facilitating the informal mentoring of newly qualified physics teachers due to the potential for ongoing teacher knowledge growth in these types of relationship. Teacher educators might consider how to build in more informal structures of feedback into the practice of new physics teachers during their training year in addition to the formal structures commonly employed such as lesson observations and feedback. This could be facilitated through working with peers or exploring roles for other teachers in a science department where a trainee physics teacher is placed. Informal mentoring could be addressed as a theme within training in England, fitting broadly within teacher standard 8 (Department for Education, 2011, p. 1) which states that teachers must fulfil wider professional responsibilities including to “develop effective professional relationships with colleagues”. Trainee physics teachers could be explicitly pointed to possible sources of informal support they may draw upon during their careers. In addition, teacher educators

in initial teacher education could seek to facilitate informal mentoring for their trainee teachers as they move into their first jobs. Ways of doing this could include projects such as that described in this study where institutional or personal contacts are leveraged to provide external informal mentoring. The enthusiasm and availability of the retired teachers suggests that this is a potentially untapped resource. Other ways of recruiting suitable retired mentors may be to follow the method of Gold (1987) who asked headteachers to recommend suitable teachers who were retiring each year. If new teachers could be paired with retiring teachers from the same school this may also serve to determine suitability for the role of mentor and provide some of the benefits of the school insider as well as the external mentor. There would be a need for caution and careful evaluation however as existing loyalties and friendships between the retired teacher and currently serving staff may surface and potentially compromise confidentiality. There may also be an extent to which peer group support by other new physics teachers may be able to provide some of the benefits of external mentoring by reducing feelings of isolation. Whilst not having the experience and teacher knowledge to draw upon, training could be provided such that peer new physics teachers could be paired and then set up to engage in regular mentoring discussions based around mutual support. Other ways of providing informal mentoring could be to pair new physics teachers with experienced physics teachers from different schools or with other external knowledgeable professionals such as teacher educators from higher education institutions or professional organisations. There may be cost implications that limit the possibility of these.

6.4 Proposals for Further Research

The question of impact on retention has proven difficult to address in this study due to the small number of participants and the impact of the Covid-19 lockdown of schools on the end of the study. Further interviews at the end of the school year to determine more accurately the intentions of the participants were not able to take place. The effect of the personal circumstances as well as the

mentoring intervention on the small number of participants also limits general comments except to say that three out of the four teachers intend to continue. In order to be able to make valid claims more generally about the effects on retention of informal mentoring by retired teachers some suggestions for subsequent study are:

- A more detailed qualitative study of the lived experience of early career physics teachers over a longer period exploring how they feel their teacher knowledge is developing and what is influencing their career decisions.
- A larger scale quantitative study of a similar mentoring intervention with a larger number of physics teachers provided with informal mentoring.

To probe further the link between informal mentoring and teacher knowledge growth for early career physics teachers I also suggest a comparative study of the effect of different kinds of informal mentoring (e.g. internal to a school, by peers, by retired teachers, by teacher educators) on physics teacher knowledge growth.

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Appendix 1 – Semi-structured interview questions for current NQT's in Physics

1. Can you tell me about your experiences of mentoring as an NQT?

2. Can you describe the support and help you received as an NQT?

3. Can you describe a positive experience of mentoring you had this year?

4. Can you describe a negative experience of mentoring you have had this year?

5. What effect do you think your experiences of mentoring have had on your development of:

   Subject knowledge

   Knowledge of general pedagogy

   Knowledge of subject specific pedagogy

6. Are you intending to continue in teaching next year? And in five years? What factors are influencing your thinking?

7. Do you have any other comments relating to your experience as an NQT you would like to mention

Appendix 2 – Recruitment Advert for Recently Retired Physics Teacher Mentors

WANTED: Recently retired science teachers for early career mentoring of newly qualified teachers

Current national data suggests that only 50% of newly qualified physics teachers remain in state-funded schools 5 years after qualifying. In worse off schools only 17% of physics teachers have a degree in physics or a related subject. Other sciences such as chemistry are following similar trends. Many reasons have been suggested for the high rate of teachers leaving the profession including stress, high workload and overbearing accountability. However there are some reasons that research has shown can be particular to science teachers including:

- Being the 'lone specialist' of a certain subject in a school
- Lack of opportunities for informal learning
- Lack of expertise in delivering practical activities
- Being unprepared for early responsibility

I am starting a project to address and evaluate how these issues can be tackled by the provision of experienced mentors for newly qualified teachers graduating from the _____ teacher training programmes. Hence I am seeking recently retired teachers of secondary science who might be willing to volunteer to be paired up with a newly qualified teacher for the period of one academic year to act as an external non-judgemental mentor. Commitment would include being willing to exchange contact details with an NQT and be available to be contacted by them for advice and support through the year. You would also be willing to participate in research activity connected with evaluating the effectiveness of this mentoring.

Appendix 3 – Introductory Meeting with Retired Teachers



Harnessing the expertise of recently retired teachers to mentor beginner teachers

Dan Cottle

Key findings of Education Policy Institute report 2018

In physics, only 50% of teachers remain in state-funded schools 5 years after qualifying.

Less than 50% of physics teachers hold a relevant degree in physics

In the worst-off schools outside London, fewer than 17% of physics teachers have a relevant degree

Available at: https://epi.org.uk/publications-and-research/the-teacher-labour-market-in-england/ [accessed 2/5/19]

Why do Physics teachers leave the profession?

Stress? Workload? Coping with amount of assessment? Yes but also:

Often being only specialist Physics teacher in a school leading to:

- *Lack of opportunity for subject specific informal learning*
- *Lack of specialist support with conceptual challenges*
- *Lack of technical expertise to deliver practical work confidently*
- *Being unprepared for early responsibility e.g. A level course leader*

Hillier, J., de Winter, J. and Twidle, J. "I Could Enjoy Teaching: The Case of Physics", *Canadian Journal of Science, Mathematics and Technology Education* 13:3 (2013) 287-302.

External mentoring can address these issues

Early career mentoring can be a "lifeline" for vulnerable physics teachers
Supports the construction of professional identity
More effective as there is no assessment element to the relationship
Personal support goes alongside – not replacing – formal CPD

Practically: *non-judgemental advice, availability, connection to community*

Cameron, D., Grant, A. "The role of mentoring in early career physics teachers' professional identity construction", International Journal of Mentoring and Coaching in Education 6:2 (2018) 128-142.

Approach based on self-determination theory (SDT)

Environment sometimes suppresses the natural desire to learn and grow. Most teachers have an intrinsic motivation that can be nurtured.

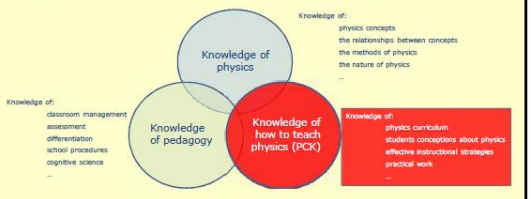
If three psychological needs are met:

- *Competence – feel abilities are improving*
- *Relatedness – feel valued and respected by others*
- *Autonomy – have ownership of own actions*

Not all schools are providing these – creative approach to finding them through making connections.

Gagné, M. and Deci, E.L. (2005) Self-Determination Theory and Work Motivation. *Journal of Organizational Behavior*, 26 (4): 331-362.
Allen, R, and Sims, S (2018) *The Teacher Gap*. Abingdon: Routledge, pp70-71.

A simple model of classroom teacher knowledge



Adapted from: Etkina, E (2010) Pedagogical content knowledge and preparation of high school physics teachers. *Phys. Rev. ST Educ. Res.* 6 020110-1-26.
Shulman, L (1987) Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review*, 57 (1): 1-22

Proposal

Pair up each new graduating Physics teacher from UoB with a named mentor (ideally recently retired alumni sympathetic to concerns and situation)
Meet each other at a social event in week of 17th – 21st June
Agree to share contact details
Commit to speaking a minimum of once per term for one academic year (2019/20) – NQT led if possible
Agree to participate in research activity connected with this – e.g. phone interviews, group discussions

Discussion:
e.g. Is it a good idea? Would you participate? Would you want/need any training? Is it feasible to meet in person or via skype/whats app ? Do you have any experience in this sort of coaching/mentoring?

Appendix 4 – Example of Completed Data Analysis Grid (Phase 1 Data Collection)

	Respondent A	Respondent B	Respondent C	Summary and key themes
Can you tell me about your experiences of mentoring as an NQT?	In school mentor very good. Mentor was a physics teacher – got on very well. Very grounded mentor. Thought about teaching in same way as me. Behaviour problems made feel demoralized. Did not feel supported in dealing with them. Put on a support plan by mentor.	NQT program. Weekly meetings for 1/3 of year with NQT mentor who was head of department. Also weekly training sessions on topics such as safeguarding, marking, planning etc.. These were good. Different teachers from around school would deliver these. Not always well organised "semi-structured training". Expectation that as a professional you would be responsible for own knowledge. Also had a physics specialist mentor who also met with once a week. Unstructured –	Felt that needed most support with managing student behaviour. Head of Faculty and 2nd in charge provided most support but "Most of the time you feel like you are on your own and then you feel do feel really stressed essentially". Not much advice available from mentor. Expected to do job not like training to be a teacher when you feel like you are guided. Now you feel like "at the end of the day they don't want the stress of talking, they've got their other issues to deal with. They just really want you to do your job well so they can do their own job."	All provided with NQT mentor, variable availability and program of activity attached to this. Support with managing behaviour a cause of unhappiness and problems. Some mentoring provided by subject specialists. Sometime felt like "on own".

		led by NQT who raised questions e.g. how to plan a lesson for a specific topic, or training on a practical. “This was quite reassuring in the sense that, as a brand new teacher, its quite hard to be looking ahead a long way. You’re kind of focused on what’s happening in the next day or two. So to have someone there who’s saying, “Ok, lets’ just think about the next few weeks,” is always quite a good thing.		
Can you describe the support and help you received as an NQT?	Support good. Weekly NQT meetings (1 hour). Attached to same form group. Saw every day. Discussed progress and admin and targets. Support plan put in place after 1st half term.	NQT mentor who would approach for help is same person who would carry out termly assessment lesson observations. Did not approach this teacher much for general questions and help – went to other	NQT mentor. V busy and barely see. Managed to see school head of behaviour eventually who provided some effective help – but not until many months had passed.	Amount of support varies from seeing and speaking to every to almost never. Same person mentor as assessor against NQT targets.

		informal contacts in the department.		
Can you describe a positive experience of mentoring you have had this year?	Camaraderie from departmental staff.	Having difficulty managing workload of planning lessons – approached subject specialist mentor (not formal NQT mentor) for help. Went through support including advice to reduce planning. This helped with confidence to see that detailed planning was not always necessary as experience was built up. Positive experience built confidence.	From an older more experienced teacher who would come in and support informally – provided some emotional support and help with behaviour of the kids.	Informal support from colleagues most beneficial but not always available.
Can you describe a negative experience of mentoring you have had this year?		Before the crisis point where had a positive experience mentioned above there were lots of other times when questions were asked		Not being listened to – no intervention.

		for support and received answers such as: 'Have a look at this website' – quite superficial. Did not feel listened to until things were quite bad. Would have liked a bit more active intervention.		
What effect do you think your experiences of mentoring have had on your development of:				
a) Subject knowledge	Not in physics but in chemistry.	Required training in handling and using radioactive sources, health and safety. Informally with another colleague for example, who showed me how to demonstrate current flowing in a circuit with charged plates.	Had some support with Physics subject knowledge from another teacher who started mid-way through the year. Needed this. Other than that only physics subject specialist in the school.	Not always possible but where it happens it is useful.

b) Knowledge of general pedagogy?			CPD organised by school about behaviour management but have not found it very helpful.	Not much effective.
c) Knowledge of subject specific pedagogy?			Had some CPD on GCSE core practicals that I was able to use in lessons.	Some on curriculum knowledge.
Are you intending to continue in teaching next year? And in 5 years? What factors are influencing your thinking?	No – already quit within 1st year. Demoralised by being on own to manage behaviour. "you didn't really feel like you were backed up by anyone". Workload high – especially marking and didn't agree with policy "you kind of felt at that point you were picking up the English departments failings…especially if it wasn't relevant to certain topics. I was doing tasks that I didn't see the point in doing". Feeling like the children were ungrateful. Not making the progress I wanted toward teacher standards e.g. with marking, lessons observations.	Not decided. Really enjoy teaching but work life balance hard. "I would like to carry on teaching. But I don't know what that looks like yet. What I do know is that working full time in teaching, as it is at the moment, is not working out for me, which is my decision for deciding to leave."	Yes 100%. "Ive gotten better and I do love that feeling when a student really appreciates your presence there and that is the best part of it easily". "it's a hard job but definitely staying in teaching"	Even split between already left, going to leave at end of year and going to stay despite reporting some similarities in experiences.

Do you have any other comments relating to your experience as an NQT you would like to mention?	Was put on NQT support plan after 1st half term in job because was not happy. Told school it was not working out and wanted to leave. School were reluctant and put in place support plan (changed timetable). No amount of support could have fixed underlying problems with the school.	Further explanation about workload: At worst ~70 hours per week. Majority of that lesson planning and trying to stay on top of syllabus. E.g. differentiating, assessing students work. Impossible to meet the schools marking policy. Cut down to ~55 hours per week by not planning as much. IN previous job as an engineer would work 40 hours per week and not take work home. If busy and had to work more – would do it but it would be temporary and would complain! See more experienced teachers still working many more hours per week than this – don't want to be like them because have a young	"At times you feel as well like you don't want to admit like in front of staff that you are really struggling some times".	

		family and need time for them.		

Appendix 5 – Participant Consent Form and Information Sheet

PARTICIPANT CONSENT FORM

Investigating the extent to which informal mentoring from recently retired teachers of physics can support newly qualified teachers of physics and influence their retention in teaching.

		Please initial each box
1	I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without any adverse consequences or academic penalty.	☐
3	I understand that research data collected during the study may be looked at by designated individuals from the University of Oxford where it is relevant to my taking part in this study. I give permission for these individuals to access my data.	☐
4	I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.	☐
5	I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.	☐
6	I understand how this research will be written up and published.	☐
7	I understand how to raise a concern or make a complaint.	☐
8	I consent to being audio recorded	☐
9	I understand how audio recordings will be used in research outputs	☐
10	I agree to take part in the above study.	☐
11	I agree for my personal data to be kept in a secure database for the purpose of contacting me about future aspects of this study.	☐

Name of Participant	Date	Signature
Name of person taking consent	Date	Signature

Information sheet for participants

Investigating the extent to which informal mentoring from recently retired teachers of physics can support newly qualified teachers of physics and influence their retention in teaching.

1. **Purpose of Study:** This study aims to explore the experiences of newly qualified teachers of physics in their first year of teaching and their intentions about continuing in the profession. It then aims to conduct a small scale inquiry into the effects of a voluntary intervention using recently retired subject specialists to informally mentor newly qualified teachers targeting the teacher knowledge base of pedagogical content knowledge.

2. **Background of Study:** Well known studies have highlighted the international shortage of science teachers, particularly in physics. This is a particularly acute problem faced in England where recruitment has not matched requirements for a number of years and retention is becoming a serious issue. One of the reasons for this is lack of support and feeling of isolation leading to physics teachers leaving the profession at a greater rate than teachers of other subjects. Physics subject–specific support is particularly highlighted. Studies have also shown the positive effect of mentoring on early career physics teachers. In normal circumstances, much of the craft knowledge of teaching is passed from experienced practitioner to beginner through extensive on the job coaching often in the context of school science departments However in the United Kingdom many newly qualified physics teachers find themselves as the sole teacher of physics in large school science departments with no colleagues to consult or discuss physics pedagogy. The intention of this work is to study whether a group of recently retired physics teachers, can help to address the issue by providing the mentoring and connection identified as a need.

3. **Methods of Study:** Semi structured interviews will take place with currently serving NQT's to explore their reasons for remaining in or leaving the profession. These conversations will be audio recorded and transcribed. All participants will be allocated a pseudonym and no personal information will be disclosed in the study. A group of recently retired science teachers willing to act as mentors will be sought by advertising through schools' networks and university alumni networks. Volunteer beginner teachers will also be recruited through the completion process of a university initial teacher training department. These volunteers will be paired up and agree to take part in informal mentoring for period of one academic year. During this year at three times a semi-structured interview will take place by phone, or in person to explore the activities and discussions taking place between the mentors and mentees and the intentions of the mentees with regard to their career in teaching. These conversations will also be audio recorded and transcribed for use in the study.

4. **What happens to the data provided?** The **research data** will be stored confidentially on the Principal Investigator's password protected computer within a separate confidential folder and within a locked cabinet for paper documents.

Your responses will be anonymised.

5. **Personal / sensitive data** will be stored confidentially using a secure password protected computer within a separate confidential folder and within a locked cabinet for paper documents.

We will ask all participants for their permission to use direct quotes.

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, in accordance with the University of Oxford's Policy on the Management of Research Data & Records.

6. **Will the research be published?**

The University of Oxford is committed to the dissemination of its research for the benefit of society and the economy and, in support of this commitment, has established an online archive of research materials. This archive includes digital copies of student theses successfully submitted as part of a University of Oxford postgraduate degree programme. Holding the archive online gives easy access for researchers to the full text of freely available theses, thereby increasing the likely impact and use of that research.

If you agree to participate in this study, the research will be written up as a thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published open access.

7. **Who has reviewed this study?**

This study has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.

8. Who do I contact if I have a concern about the study or I wish to complain?

If you have a concern about any aspect of this study, please speak to the researcher, or their supervisor who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the relevant chair of the Research Ethics Committee at the University of Oxford who will seek to resolve the matter in a reasonably expeditious manner: Chair, **Social Sciences & Humanities Inter-Divisional Research Ethics Committee**; Email: ethics@socsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact

If you are prepared to participate in this research please complete and sign the Participant Consent Form attached and return by 30/7/19.

Thank you.