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Does teaching outside of science subject specialism at Key Stage 3 have an adverse effect on standards?

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Abstract.

Following the review of education in Wales by Professor Graham Donaldson in 2015. The Welsh Government have committed to implementing the new curriculum, as outlined in the Successful Futures document, in all secondary schools in Wales from 2022. Subsequently, science teachers in Wales will be called upon to deliver more lessons outside of their subject specialisms. This study aims to understand the issues and challenges post graduate science student teachers face when teaching outside of their specialisms. The study also investigates what methods and strategies student teachers rely on to overcome the challenges and which methods they perceive as the most effective. Although the findings of the study indicate that students' had negative preconceptions about their ability to successfully teach outside of their specialism the study also concludes that the standards of the lessons taught were not adversely affected. Finally, the study considers what the university can do to help students overcome the challenges in the future.

Introduction.

Most global teacher education programmes involve student teachers spending time in both higher educational establishments and schools. At present, most Initial Teacher Education (ITE) students in the UK follow the Post Graduate Certificate in Education (PGCE) course as the major route into secondary school teaching. ITE students on this course will spend approximately one third of their time in higher education and two thirds of their time on school placement. The distinction that is often made between the university and school settings is that the university provides the theoretical perspective on teaching and learning and the school provides a setting for contextualised and experimental learning. In addition to this, it is also true that universities play a major role in ITE students' development of subject content knowledge (Childs and Mc Nicholl, 2007a).

At present PGCE courses in Wales prepare secondary ITE students to achieve the Professional Standards for Qualified Teacher Status (QTS). University X is based in South Wales and has a long standing history of providing teacher education. PGCE courses in the university are managed in partnership with secondary schools. This partnership is responsible for the teaching and assessment

of PGCE students, which is carried out by university tutors and mentors in partnership schools. The mentors are supported by a training and quality assurance program which is managed by university staff. University and school partnership staff work closely with student teachers to assess and monitor progress throughout the course. A requirement of successfully gaining QTS is that student teachers are proven to be effective classroom teachers. This is assessed by observational lessons. During school placement student teachers will be observed teaching by university tutors and school mentors and their lessons graded on a 4 point scale, excellent, good, satisfactory, or unsatisfactory. Students who are graded unsatisfactory will not be eligible for QTS.

The introduction of the National Curriculum for Science (DES and Welsh Office, 1989) made the study of all science subjects compulsory for school children in England and Wales aged 5 to 16 compulsory. This directly led to science teachers becoming 'teachers of science' rather than experts in one particular science discipline. Shulman (1986) demonstrated the importance of secure subject knowledge in his seminal study of knowledge and teaching. The government standards for science teachers also outline expectations that all teachers have high levels of knowledge of biology, chemistry and physics. However, some researchers have suggested that in reality this is not necessarily the case (Childs and Mc Nicholl, 2007a). Across the UK there has been well-publicised shortages of science teachers, particularly in the disciplines of chemistry and physics and even though various government initiatives to recruit more science teachers has achieved some success evidence suggests that this increase in applicants has come mainly from biologists, often with inadequacies in their knowledge of the other science disciplines (Smith, 2010).

Much has also been written about the declining trend of certain secondary school subjects, particularly science (Smith, 2011). This has raised fears of a possible skills shortage that could, potentially, have an adverse effect on the prosperity of the United Kingdom's economy and a consequent economic decline (Confederation of British Industry, 2011).

Twenty five years after the National Curriculum was first introduced the Welsh Government Education Minister commissioned Professor Graham Donaldson to undertake a comprehensive and wide-ranging review of the national curriculum and testing (BBC News, 2015). The results of the review offered a wide and thorough analysis of education in Wales and made far reaching and fundamental recommendations. These recommendations have been accepted by the Welsh Government and will be phased into a new secondary curriculum starting in 2022. The new curriculum will contain six areas of learning and experience (AoLE). Science and technology will be amalgamated to form one of the AoLE's. At present the proposed format will be based around learning progressions that will run through subject content areas entitled 'Big Ideas'. There will be a

number of 'Big Ideas' each with a scientific and technological theme interwoven. Current expectations are the teachers will be responsible to deliver the whole content of their AoLE. The implications of this are that science teachers will have to deliver an even wider array of subject areas than before.

As it is not an uncommon phenomenon that science teachers will be expected to teach outside of their specialism and that future teachers will be expected to deliver an even wider curriculum many researchers have questioned why there have been so few studies to investigate the implications of this on classroom practice (Childs and Mc Nicholl, 2007a).

The central purpose of this study is to investigate the experiences and lesson outcomes of PGCE physics, chemistry and biology student teachers at a university in South Wales (University X) when they teach lessons outside their specialist disciplines at Key Stage 3 (KS3). The study will investigate students' preconceptions and whether or not there is a detriment to the standard of observed lessons when PGCE science teachers teach outside of their specialist discipline. Furthermore it will investigate what methods are, and can be, used to facilitate students' subject and pedagogical knowledge. Based on the findings the study will outline any possible recommendations that can be made to the current PGCE course to better equip students' to teach outside their specialist areas. This will then be used to inform current practice at university X and its partnership schools.

Literature Review.

Teaching science in separate disciplines by specialist teachers in those disciplines has been advocated by many organisations such as the Campaign for Science and Engineering (CASE) and the Royal society of Chemistry (RSC). Kind and Kind (2011) reported that both these organisations held the view that the best teachers are those that have specialist subject content knowledge (SCK). Other researchers support these claims. In their study on biology being taught by non-specialists in secondary schools Mak, Yip and Chung, (1999) conclude that non-specialists do not possess adequate knowledge in biological science for them to teach competently in the biology curriculum and that the converse argument was also true when the physics and chemistry curriculum areas were taught by biology specialists.

These views are not limited to professional organisation outside the teaching profession. A study by Childs and Mc Nicholl (2007a) reported that novice teachers held major concerns about their classroom practice when teaching outside of their subject specialism. They perceived that their lessons were constrained and lacking in challenge due to their insecure subject knowledge. Their

findings were also not limited to novice teachers. Experienced teachers were reported as *feeling like novices* when teaching outside of the comfort zone of their subject specialism. A separate study by Osbourne and Simon (1996) supported this notion concluding that a lack of subject knowledge led to a lack of confidence that had real implications on teaching and planning.

As explained earlier, in the introduction, since the implementation of the National Curriculum in 1989 teachers have been increasingly required to teach outside of their subject specialism. Furthermore, following the recommendations of the Donaldson report and the introduction of the new the 'Successful Future' curriculum in secondary schools in 2022 this trend will continue at an increasing rate. Therefore, if the above claims are true there could, potentially, be serious implications for future science teaching.

However, these claims have been strongly contested in recent years by a number of researchers. In a report on chemistry teachers Kind and Kind (2011) revealed that possession of a degree in chemistry (or related subject) was no guarantee of good subject knowledge for teaching the subject. They argue that many graduates had 'learned chemistry' and believed themselves to be experts in the field without ever considering the underlying concepts of the subject or being challenged about inaccurate ideas. They also suggested that the chemistry graduates own experiences as pupils in secondary schools was a contributing factor in their classroom practice, suggesting that their teaching often reflected the teaching they received during their school science experiences. Their own inability to develop good conceptual understanding during their school years restricted their effective teaching of chemistry topics.

Ofsted (2008) also reported that, in many cases, even when science teachers possessed a degree in their specialist subject discipline they showed an inability to engage with what and how pupils were learning. Rather than directly involve the pupils in their own learning processes teachers merely passed on information without any expectation of pupils' direct engagement in the process. Other researchers (Osbourne et al., 2011) have questioned why some specialist science teachers' pedagogical practises are so uninviting to so many students. They add that many teachers with relevant subject knowledge fail to establish the primary objective of communicating their subject in an effective manner. Also, a recently published article by Kind (2014) challenges claims that a degree in a specialist science discipline is a *de facto* guarantee that graduates will be effective subject teachers, concluding that even well qualified, academically able novice teachers hold significant misconceptions of basic scientific concepts.

Shulman (1987) identifies the possession of good subject knowledge as a prerequisite for effective teaching. However, teaching goes beyond the simplistic notion that a good knowledge of SCK is

sufficient. It also requires what Shulman (1987) refers to as good pedagogical content knowledge (PCK) which he defines as:

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. (Shulman, 1987, p. 8)

To better understand the mechanisms of PCK and its implications in science lessons, Summers et al., (1998) classified PCK into 4 distinct areas:

- appropriate scientific terms and language to use with children;
- what to emphasise (not just what is the case but what is not the case);
- how to simplify validly what are often complex ideas;
- simple technical knowledge (e.g. why nominally identical bulbs do not glow equally and what to do about this). (Summers et al., 1998, p. 171)

Many writers have identified concerns for teachers' PCK when their SCK is limited (Roth et al., 1986; Garnett & Tobin, 1988; Tobin & Fraser, 1990) all emphasise the important link between SCK and PCK for successful science teaching. In addition, Garnett and Tobin (1988) reported that good knowledge of their subject enabled science teachers to focus on instructional strategies that assisted pupils' learning. Hasweh (1987) also identified that differences in SCK changed the ways that teachers planned. An example of this was in their use of questioning, outside subject specialism teachers' questions were closed and at a lower cognitive level.

Several research studies make recommendations, although precise methods of the best way to promote development of PCK with pre service student teachers in a way that generates students learning are hard to find (Kind, 2014).

Kind (2014) also holds the view that pre-service teachers enter teaching as novices, and that novices and experts differ in the ways they approach teaching. Although both novices and experts hold similar SCK, the expert teachers' have well developed PCK that help students' build up understandings of topic components gradually. As the shift from novice to expert teacher is unlikely to occur in the timescale of the PGCE course it is pivotal that we find ways to quickly develop student teachers' SCK and PCK. One of the main challenges of teacher educators is how do we marry the learning that occurs in school between teachers and our own, university based, teaching.

According to Eraut (2000) workplace learning is a very under-researched area in science education. Donnelly (2000) reports that when a science teacher talks to another with the intention to help them further understand a particular area of a subject, or how best to demonstrate a classroom practical

it would certainly be considered as development of PCK. Others have also written about the advantages of school subject departments being excellent sites for student teachers to develop their PCK. Mc Nicholl, Childs and Burn (2013) reported that when science teachers frequently interacted with colleagues within their science departments a number of aspects of PCK became intertwined and developed. However, Kind (2014) warns that even the most inviting school environment for teacher education is highly unlikely to be able to allocate sufficient time and resources to allow student teachers to effectively develop their PCK. Youens and Mc Carthy (2007) also question whether or not student teachers would approach other school staff for support adding that some felt it would adversely affect their assessments or could feel humiliating.

Reflected dialogues are becoming more prevalent as a strategy for learning amongst educators (Hehring et al., 2010, p.411) and this process is embedded into the PGCE program with mentors being allocated to all student teachers in schools. The mentors and students meet on a weekly basis allowing students to reflect on their practice and be conscious of the potential for learning through their work Cox (2005). However difficulties arise when students, while appearing to have an open and professional relationship with their school mentors, are reluctant to approach them for advice concerned that they would be viewed in a negative light Youens and Mc Carthy (2007).

Other researchers place the university- based teacher education system at the heart of why teachers are being trained without well-developed PCK. Taber and Tan (2011) claim that the university- based teacher education system in the UK is flawed and that some countries are successfully extending their teacher education methodologies to be solely school based. However, Burn, Childs and Mc Nichols (2007) conducted a study that tracked two student teachers in two such environments in different science departments. Both departments offered professional environments where collaboration and discussions amongst staff at all levels was encouraged. They concluded that the issue of how to enable student teachers to access and develop PCK was not resolved. It has also been reported by Houston (2008) that school based teacher education leaves student teachers under-prepared for the realities of classroom life.

It is clear that there are many diverse views and theories on the effectiveness of teachers when they teach outside their subject specialism. The next section of this study describes the methodology used to investigate this further with the current cohort of PGCE students' at university X during their Professional Teaching Experience 1 (PTE1) in conjunction with our partnership schools.

Methodology.

This study is about the preconceptions and challenges that student science teachers experience when they teach lessons outside their subject specialism. It will also investigate methods that students currently use to gain knowledge outside of their specialism and what future methods can be used to facilitate students' subject and pedagogical knowledge in the future. The chosen method of study was that of a case study. The main reason for this choice is that a case study allows an opportunity for aspects of a problem to be studied in some depth within a limited time scale (Bell, J. 1999). This was pivotal to the success of this study as the data had to be collected and analysed over a period of three months. A further reason for this choice is that case studies are also ideally suited to a researcher working alone, which again suited this study (Basil, N.T. 2010).

When science student teachers embark on their studies at university X they are given a range of tests to assess their knowledge across the science disciplines. Although these tests were not part of this research study they highlighted the concerns that science teachers had with regard to their lack of subject knowledge outside of their specialisms. Students were worried about the potential effect on standards when they would be teaching outside of their specialisms, thus proving the research study to be viable. In order to assess this further students a questionnaire was prepared (Appendix 1. Survey 1). This questionnaire was checked for suitability by another member of staff in the science department at university X and was deemed fit for purpose. Ethical considerations of the research study were adhered to in line with the BERA guidelines for Educational research (BERA 2011) and the university ethics form (Appendix 2. Anonymised university ethics form).

Prior to the questionnaire being distributed to the science students' potential participants were informed of the nature of the research project (Appendix 3. Information for participants). The relevance of the research study was also explained to the potential participants (Kumar, R. 2014).

Informed consent was then obtained (Appendix 4. Consent form) so that the potential participants were fully aware of what they were agreeing to. Participants' were made fully aware of their right to withdraw at any time, and that if they withdrew their data would be subsequently deleted and removed from the study (Thomas, G. 2010). All data collected during the study was to be anonymised and saved on a password protected USB memory that only the researcher had access to. This USB memory was to be kept, securely, at university X.

There are currently 18 students studying the biology, chemistry and physics PGCE courses. All of these students gave their informed consent to be involved in the research study.

The data collected by survey 1 (Appendix 1. Survey 1) was mainly of a quantitative nature, however questions 4 and 8 did allow participants some freedom to elaborate on their answers. At the end of PTE1 a second survey (Appendix 5. Survey 2) was issued, this was similar in nature to survey 1. However, question 5 was changed slightly to focus on which resources students' found most effective to develop their subject knowledge outside of their specialism to allow further analysis of this area. Both surveys were designed to measure the students' confidence in teaching inside and outside of their specialism. The surveys also questioned the students' on their perceived effect on standards when they taught outside their specialisms. The results of this are shown in the relevant tables in the Analysis and Findings section, below. The confidence levels were measured out of a maximum score of 10. The mean calculations allow for a quick comparison across subject areas whilst the Standard Deviation (S.D.) calculation is used to show how much variance exists in each score (Thomas, G. 2010, p.218).

The surveys were also designed to collect data on what topics they needed to develop, what resources did they find useful and what could the university do to facilitate subject knowledge outside of their specialism. A pre-test / post-test design was utilised so that it could measure a change in students' conceptions over the period of their first school placement. A full analysis of these results follows in the next section. Whilst the main advantage of a pre-test / post-test design is its ability to measure change, there are disadvantages to this method, most notably is that it measures *total change* without ascertaining whether or not extraneous variables are responsible for producing change in the dependent variable (Kumar, R. 2014). Semi structured interviews with students or focus groups could have proved to be useful tools to provide further information on the independent variables responsible for change. This would have also added a further degree of triangulation to the research which would have improved the validity of the findings. However, the time constraints of the study prevented this as conducting and transcribing interviews is a very time consuming process Basit N.T. (2010).

During their first placement the students were observed teaching a minimum of three lessons, and usually four. These observations were undertaken by a mix of university tutors and mentors within placement schools. The results of the lesson observations were stored on university X's lesson observation website. All data collected from lesson observations was then anonymised prior to being transferred to the researcher's USB memory device. This was achieved by students' names being replaced with student numbers, also dates of lesson observations were anonymised to ensure that students and schools could not be identified by cross referencing with university X's lesson observation website. These methods were utilised to provide the highest possible degree of anonymity (Thomas, G. 2011).

To ensure consistency in the observation process a meeting was arranged with all school mentors and university tutors, prior to PTE1, to match the standards required for QTS with the rubric of the university lesson observation documentation. Standards observed, during the observation lessons were graded on a 4 point scale, consistent with university protocol. To facilitate data collection this 4 point scale was represented numerically with excellent awarded 4, good 3, adequate 2 and unsatisfactory 1. The lesson outcomes were recorded in columns D,E,F and G of the lesson observation data capture sheet (Appendix 6. Lesson observation data capture, example). Column B denotes the specialism of the students, while rows 'Observation' and 'Topic' represent the lesson observations and subject topics within the science curriculum respectively. The standards were recorded in the following order, knowledge and understanding, teaching and planning, teaching – monitoring and assessing, teaching – class management. These are represented by the numerical values in the columns D to G of the spreadsheet (Grading Rows) and are separated by commas. The cumulative scores of the lessons are recorded in 'Total marks' rows. Column H calculates mean score of the student when teaching inside of specialism and column I the mean when teaching outside of specialism. Conditional formatting was then used to compare the mean values. If a higher value was obtained when teaching outside of specialism then the cell in column I would appear turquoise, no difference in value is shown as orange and a lower value when teaching outside of specialism was denoted by pink. This allowed a quick comparison to be made. The full results are shown in tables 4,5 and 6 in the 'Analysis and Findings' section below. The first lessons observed in placement school were always joint observations with the university tutor, the school mentor and usually the classroom teacher. After the joint observations the outcomes were discussed in detail to reach agreement. This triangulation method ensured validity of the data and further enhanced consistency in the observation process.

Only a sample of 13 teachers could be used in the lesson observation study as not all teachers were allocated timetables that allowed them to teach inside and outside of their specialisms. However, this sample of 13 teachers still provided data from 50 different lessons, this was considered a valid sample size for this case study. All lessons were observed during PTE1.

Analysis and Findings.

The first part of the analysis looks at data collected from the student surveys prior to Professional Teaching Experience 1 (PTE1). The students are grouped into their subject specialism areas. The findings, below, are presented according to the answers to the first research question:

Question 1) At the moment how confident are you in teaching Biology, Chemistry and Physics?

(Award a mark out of 10).

The pre PTE 1 answers are shown below). Column 2 displays the students' specialism and columns 3, 4 and 5 the students' answers.

(Note S.D. = Standard Deviation.

Table 1. Confidence of biologists.

	Specialism	Biology	Chemistry	Physics
Student 1	Biology	8	5	6
Student 2	Biology	9	5	5
Student 3	Biology	9	8	6
Student 4	Biology	9	7	6
Student 5	Biology	7	5	5
	Mean	8.4	6	5.6
	S.D.	0.80	1.26	0.49

As can be seen from the 'mean row' in table 1 above, overall the biologists felt more confident teaching inside their subject specialism and were less confident in teaching chemistry and physics, with physics being the least confident. The low Standard Deviation figure for the physics column implies that there was not a great deal of variance in the individual answers to this question.

Table 2. Confidence of chemists.

	Specialism	Biology	Chemistry	Physics
Student 6	Chemistry	8	7	5
Student 7	Chemistry	6	7	5
Student 8	Chemistry	9	8	4
Student 9	Chemistry	5	7	4
Student 10	Chemistry	10	10	8
Student 11	Chemistry	6	9	3
Student 12	Chemistry	6	8	3
Student 13	Chemistry	6	9	4
	Mean	7.00	8.13	4.50
	S.D	1.66	1.05	1.50

As can be seen from the 'mean row' in table 2 above, overall the chemists felt more confident teaching inside their subject specialism and were less confident in teaching biology and physics, with physics being the least confident. The higher Standard Deviation figures for the biology and physics column implies that there was some variance in the individual answers to this question.

Table 3. Confidence of physicists.

	Specialism	Biology	Chemistry	Physics
Student 14	Physics	3	6	8
Student 15	Physics	3	6	8
Student 16	Physics	7	7	9
Student 17	Physics	4	4	7
Student 18	Physics	2	3	9
	Mean	3.8	5.2	8.2
	S.D	1.72	1.47	0.75

As can be seen from the 'mean row' in table 3 above, overall the physicists felt more confident teaching inside their subject specialism and were less confident in teaching biology and chemistry, with biology being the least confident. The higher Standard Deviation figures for the biology and chemistry columns imply that there was some variance in the individual answers to this question.

The findings from question 1 of the pre PTE1 survey clearly show that the students were less confident when asked to teach outside their subject areas. Question 4 of the survey asked students:

What topics need developing?

Table 3a. Biologists.

		SURV		
		Q4) What topics need developing?		
	Specialism	Biology	Chemistry	Physics
Student 1	Biology		Y	Y
Student 2	Biology		Y	Y
Student 3	Biology		Y	Y
Student 4	Biology		Y	Y
Student 5	Biology		Y	Y

Table 3b. Chemists.

	Specialism	Q4) What topics need developing?		
		Biology	Chemistry	Physics
Student 6	Chemistry			Y
Student 7	Chemistry		Y	Y
Student 8	Chemistry		Y	Y
Student 9	Chemistry	Y		Y
Student 10	Chemistry			Y
Student 11	Chemistry	Y	Y	Y
Student 12	Chemistry	Y		Y
Student 13	Chemistry	Y		Y

Table 3c. Physicists.

	Specialism	Q4) What topics need developing?		
		Biology	Chemistry	Physics
Student 14	Physics	y	Y	
Student 15	Physics	Y	Y	
Student 16	Physics	Y	Y	
Student 17	Physics	y	Y	Y
Student 18	Physics	Y	y	Y

100% of biologists and physicists answered that they needed to develop all topics outside their specialism, this is denoted by 'Y' in the above tables. 100% of chemists identified the need to develop their physics topics, but only 50% felt the need to develop their biology see tables 10,11,and 12 The biologists were the most confident when teaching within their specialism with 100% reporting that they were confident to do so. 38% of chemists and 40% of physicists reported that

they also needed to develop topics within their subject specialism. This could be due to the fact that many of the chemists and physicists do not hold chemistry or physics degrees, however further research would be required to substantiate this.

As might be expected from the above results, prior to PTE1, 78 % of students expressed concern that teaching outside of their specialism would have a detrimental effect to the standard of the lesson taught. These results are shown below in table 3d 'Y' denotes a perceived effect on standards 'N' denotes no effect.

Table 3d. Perceived effect on standards.

	Specialism	Q7) Effect on standards?
Student 1	Biology	N
Student 2	Biology	Y
Student 3	Biology	Y
Student 4	Biology	Y
Student 5	Biology	Y

Student 6	Chemistry	N
Student 7	Chemistry	Y
Student 8	Chemistry	Y
Student 9	Chemistry	Y
Student 10	Chemistry	N
Student 11	Chemistry	Y
Student 12	Chemistry	Y
Student 13	Chemistry	Y

Student 14	Physics	Y
Student 15	Physics	Y
Student 16	Physics	Y
Student 17	Physics	Y
Student 18	Physics	N

The second part of the study analysed the lesson grading's of students who taught inside and outside of their subject specialism in PTE1. This was designed to test whether or not the students' preconceptions of teaching standards when teaching outside of their specialisms were valid.

Depending on the school and structure of the curriculum, some students did not have the opportunity to teach outside of their specialism. A total of 13 students were eventually analysed, this equated to an analysis of 50 different lessons taught by specialist / non-specialist teachers.

Table 4. Biology Students.

	Specialism						Mean inside specialism	Mean outside specialism
Student 1	Biology	Observation	A	B	C	D		
		Topic	Biology	Chemistry	Biology	Biology		
		Grading	3,3,2,3,	4,4,3,3,	3,3,2,3	3,3,2,3		
		Total Mark	11	14	11	11	11	14
Student 2	Biology	Observation	A	B	C	D		
		Topic	Chemistry	Chemistry	Biology	Biology		
		Grading	3,3,2,3,	3,3,3,3	3,3,2,3	3,3,3,3		
		Total Mark	11	12	11	12	11.5	11.5
Student 3	Biology	Observation	A	B	C	D		
		Topic	Physics	Biology	Chemistry	Physics		
		Grading	2,2,2,2	2,2,2,2,	2,2,2,2	2,2,2,2		
		Total Mark	8	8	8	8	8	8
Student 4	Biology	Observation	A	B	C	D		
		Topic	Physics	Biology	Biology	Biology		
		Grading	3,2,2,3,	2,2,2,2	3,2,3,2,	2,2,2,2		
		Total Mark	10	8	10	8	8.7	10

Table 5. Chemistry students.

	Specialism						Mean inside specialism	Mean outside specialism
Student 5	Chemistry	Observation	A	B	C	D		
		Topic	Chemistry	Chemistry	Physics	Chemistry		
		Grading	2,2,2,2	3,3,2,2,	4,3,3,2	4,3,3,4		
		Total Mark	8	10	12	14	10.7	12
Student 6	Chemistry	Observation	A	B	C	D		
		Topic	Chemistry	Chemistry	Chemistry	Biology		
		Grading	3,3,3,3,	3,3,3,3	3,3,3,3	3,3,3,3		
		Total Mark	12	12	12	12	12	12
Student 7	Chemistry	Observation	A	B	C	D		
		Topic	Physics	Chemistry	Biology	Physics		
		Grading	2,2,2,2	2,2,2,2	2,2,2,2	2,2,2,2		
		Total Mark	8	8	8	8	8	8
Student 8	Chemistry	Observation	A	B	C	D		
		Topic	Chemistry	Biology	Physics			
		Grading	2,1,2,1	2,2,1,1	2,2,2,2			
		Total Mark	6	6	8		6	8
Student 9	Chemistry	Observation	A	B	C	D		
		Topic	Chemistry	Chemistry	Biology	Chemistry		
		Grading	2,2,2,2,	2,2,2,2,	2,2,2,2	2,2,2,2		
		Total Mark	8	8	8	8	8	8

Table 6. Physics students.

	Specialism						Mean inside specialism	Mean outside specialism
Student 10	Physics	Observation	A	B	C	D		
		Topic	Biology	Biology	Biology	Physics		
		Grading	3,2,2,3,	3,2,2,2	3,3,3,2	2,3,2,3		
		Total Mark	10	9	11	10	10	10
Student 11	Physics	Observation	A	B	C	D		
		Topic	Physics	Biology	Physics	Physics		
		Grading	3,2,3,3,	2,3,2,2,	3,2,2,2,	3,2,2,2		
		Total Mark	11	9	9	9	9.7	9
Student 12	Physics	Observation	A	B	C	D		
		Topic	Chemistry	Physics	Biology	Physics		
		Grading	3,2,2,2	3,2,2,2	3,2,2,3	3.2.2.3.		
		Total Mark	9	9	10	10	9.5	9.5
Student 13	Physics	Observation	A	B	C			
		Topic	Physics	Chemistry	Physics			
		Grading	3,3,2,3,	4,3,4,3,	3,3,2,3,			
		Total Mark	11	14	11		11	14

The process for awarding marks is explained in the previous section (Methodology). The marks were analysed to produce mean marks for teaching inside and outside of specialism. The mean outside specialism cells are compared with the mean inside specialism cells and subsequently colour coded using conditional formatting equations. Pink, if the outside specialism lessons were marked lower than the inside specialism lessons. Orange, if the outside specialism lessons were marked equal to the inside specialism lessons. Turquoise, if the outside specialism lessons were marked higher than the inside specialism lessons.

On analysis of the results it can be shown that, despite students' preconceptions, only 8% of students were judged to achieve lower standards in lessons when they taught outside of their specialism. 54% were judged to teach consistently well inside or outside of their specialism and 38% were judged to teach better lessons outside of their specialism. Further work beyond the scope of this study would be needed to ascertain why this was the case, possibly including interviewing students.

Furthermore, on comparing tables 1 and 4 above, despite biologists being the least confident in teaching physics there is no evidence to suggest that their physics lessons were taught to a lower standard. A similar correlation can be seen by comparing tables 2 and 5 above, again with chemists being least confident teaching physics there is no evidence to support this, in fact, students 5 and 8 performed better when teaching physics compared with their specialism of chemistry.

Table 3 shows that physicists' pre conceptions of their ability to teach biology was very low, a mean score of 3.8/10 compared with a mean score of 8.2/10 in their confidence to teach physics. While table 7 does show a slight decline in standards when physics students taught biology, the results were much higher than students' expectations. On analysis of students 10, 11 and 12 (those who were observed teaching physics and biology) two students taught biology and physics to equable standards, with only one student achieving a slightly lower grade when teaching outside of specialism.

It is clear that despite the students' preconceptions prior to PTE1 that standards would be lower when they taught outside of their specialisms, this not found to be the case in practice.

The third part of this study analysed students confidence in teaching outside of their specialism after completing their first term of PTE1. The students completed a second survey with largely similar questions to the first (Appendix 5. Survey2).

Question 1, was, again, used to measure confidence of the students when asked to teach inside and outside of their specialism. Condition formatting equations were used to compare with the results prior to PTE1.

The findings are shown below:

Question 1. At the moment how confident are you in teaching Biology, Chemistry and Physics? (Give a mark out of 10).

Table 7. Confidence of biologists after completing PTE1.

	Specialism	Biology	Chemistry	Physics
Student 1	Biology	<u>8</u>	5	6
Student 2	Biology	<u>8</u>	6	6
Student 3	Biology	<u>10</u>	9	8
Student 4	Biology	<u>9</u>	7	5
Student 5	Biology	<u>8</u>	6	6
	Mean	8.6	6.6	6.2
	S.D.	0.80	1.36	0.98

The 'turquoise cells' show areas of increased confidence, compared to when this question was asked prior to PTE1. The 'red cells' show areas of decreased confidence. It can be shown that, overall, the biologists had increased confidence in teaching outside of their subject areas. The standard deviation figure in the physics column has increased from 0.49 (table 1) to 0.98. This would imply that there is some increase in variance of the confidence of individual biologists in teaching physics. The standard deviation in the chemistry column has not significantly changed from table 1 implying similar variation in confidence when biologists taught chemistry.

Table 8. Confidence of chemists after completing PTE1.

	Specialism	Biology	Chemistry	Physics
Student 6	Chemistry	7	<u>6</u>	5
Student 7	Chemistry	7	<u>7</u>	5
Student 8	Chemistry	8	<u>6</u>	2
Student 9	Chemistry	7	<u>7</u>	5
Student 10	Chemistry	10	<u>10</u>	8
Student 11	Chemistry	7	<u>8</u>	4
Student 12	Chemistry	6	<u>7</u>	5
Student 13	Chemistry	6	<u>10</u>	5
	Mean	7.25	7.63	4.88
	S.D	1.20	1.49	1.54

Again, it can be clearly shown that chemists had increased confidence when teaching outside of their specialism after PTE1. However, 50% had lost confidence in teaching within their specialism, the reasons for this are partly explained by table 11 below which highlights an increased need for topic development within the subject specialism of chemistry however, the full reasons are, unfortunately, outside the scope of this study and warrant further research. The standard deviation figure in the biology column has decreased from 1.66 (table 2) to 1.20. This would imply that the variance in individual chemists' confidence in teaching biology has decreased, and that the chemists were becoming more confident in teaching biology. The standard deviation in physics remains similar to pre PTE 1 figures, again, implying similar variation in confidence when chemists taught physics.

Table 9. Confidence of physicists after completing PTE1.

	Specialism	Biology	Chemistry	Physics
Student 14	Physics	4	7	<u>8</u>
Student 15	Physics	5	7	<u>10</u>
Student 16	Physics	8	8	<u>8</u>
Student 17	Physics	7	7	<u>8</u>
Student 18	Physics	4	5	<u>9</u>
	Mean	5.6	6.8	8.6
	S.D	1.62	0.98	0.80

Again, table 9 illustrates that physicists had also increased confidence when teaching outside their subject specialism after PTE1. Table 9 also shows that the physicists have the biggest increase in confidence in teaching within their own subject area out of the 3 disciplines, although student 16 has dropped marginally from a score of 9 to 8. The standard deviation figure in the chemistry column has decreased from 1.47 (table 3) to 0.98. This would imply that the variance in individual physicists' confidence in teaching chemistry has decreased, and that the physicists were becoming more confident in teaching chemistry. The standard deviation in biology remains similar to pre PTE 1 figures implying similar variation in confidence when physicists' taught biology.

These results clearly show that the confidence of students' teaching outside of their specialisms had greatly increased after PTE1.

In the second survey students were again asked which areas of study needed improving.

Question 4. What topics need developing?

Findings are shown below:

Table 10. What topics do biologists need to develop?

	Specialism	Q4) What topics need developing?		
		Biology	Chemistry	Physics
Student 1	Biology		Y	
Student 2	Biology			Y
Student 3	Biology		Y	Y
Student 4	Biology		Y	Y
Student 5	Biology		Y	Y

As previous 'Y' identifies the topics that need developing. The green cells depict areas that students had identified needed developing prior to PTE1 but now felt confident to teach those areas. This data correlates with the chemistry outcomes for student 2 in table 7.

Table 11. What topics do chemists need to develop?

	Specialism	Q4) What topics need developing?		
		Biology	Chemistry	Physics
Student 6	Chemistry		Y	
Student 7	Chemistry		Y	Y
Student 8	Chemistry		Y	Y
Student 9	Chemistry		Y	Y
Student 10	Chemistry			Y
Student 11	Chemistry		Y	Y
Student 12	Chemistry	Y		Y
Student 13	Chemistry	Y		Y

Again, when comparing this data with table 8 this correlates with the increased confidence of student's 6, 9 and 11 when outside their subject areas and goes some way to explain the decrease in some chemists' confidence when teaching inside their specialism. The red cells depict areas that were not identified as areas needed developing prior to PTE1 but now need developing after PTE1. Further research work could explore this in greater depth.

Table 12. What topics do physicists need to develop?

		Q4) What topics need developing?		
	Specialism	Biology	Chemistry	Physics
Student 14	Physics	Y	Y	Y
Student 15	Physics	Y	Y	
Student 16	Physics	Y		
Student 17	Physics			Y
Student 18	Physics	Y	Y	Y

Again there is a general correlation with the findings of table 9 for students 14, 16 and 17 which shows that students' confidence in teaching outside of their specialism develops as they develop their knowledge over the course of PTE1.

The general increase in confidence of all students in teaching outside their subject area after PTE 1 is clear by analysing the students' responses to question 7 in the second survey (Appendix 5. Survey2). 61% of students now expressed concern that teaching outside of their specialism would have a detrimental effect to the standard of the lesson taught compared to 78% prior to PTE1. The students' whose opinions changed from 'yes' to 'no' are illustrated by the green cells in tables 12a, below, those whose opinions changed from 'no' to 'yes' are represented by the red cells. Again 'Y' denotes a perceived effect on standards 'N' denotes no effect.

Table 12a. Perceived effect on standards post PTE1.

	Specialism	Q.7) Effect on standards?
Student 1	Biology	N
Student 2	Biology	Y
Student 3	Biology	N
Student 4	Biology	Y
Student 5	Biology	Y
Student 6	Chemistry	N
Student 7	Chemistry	Y
Student 8	Chemistry	Y
Student 9	Chemistry	N
Student 10	Chemistry	N
Student 11	Chemistry	Y
Student 12	Chemistry	N
Student 13	Chemistry	Y
Student 14	Physics	Y
Student 15	Physics	Y
Student 16	Physics	Y
Student 17	Physics	N
Student 18	Physics	Y

The fourth part of this study focused on what resources students found most useful to develop their subject knowledge when teaching outside of their subject specialism. The first survey (Appendix 1. Survey 1) gave students the choice of textbooks. Information on line or 'other'. This was based on informal discussions in curriculum studies lesson in the university. The second survey, after PTE1, (Appendix 5. Survey 2) included the option of 'Discussions with science staff' this option was added to ascertain if Donnelly (2000) Nicholl and Childs and Burn (2013) were correct in reporting that this was an effective way of developing knowledge as previously noted in the literature review.

In the second survey students' were also asked to note which method they had found most effective. These choices are denoted by the 'yellow cells' in table 13 below.

Q5) What resources are used?

The results are shown below, 'Y' denotes a positive response:

Table 13. What resources are used to develop knowledge outside of subject specialism?

	Specialism	Q5) What resources are used?		
		Textbooks	Online	Discussions
Student 1	Biology	Y	Y	Y
Student 2	Biology	Y	Y	Y
Student 3	Biology	Y	Y	Y
Student 4	Biology	Y	Y	Y
Student 5	Biology	Y	Y	Y

Student 6	Chemistry	Y	Y	
Student 7	Chemistry	Y	Y	
Student 8	Chemistry	Y	Y	Y
Student 9	Chemistry		Y	Y
Student 10	Chemistry	Y	Y	Y
Student 11	Chemistry	Y	Y	
Student 12	Chemistry			
Student 13	Chemistry	Y	Y	Y

Student 14	Physics	Y	Y	Y
Student 15	Physics	Y	Y	
Student 16	Physics	Y	Y	Y
Student 17	Physics		Y	Y
Student 18	Physics	Y	Y	

Totals:

Textbooks – 15, On-line resources – 18, Discussions with departmental staff – 13

It is interesting to note that only 3 students reported that discussions with departmental staff were the most effective ways to gain knowledge as opposed to 12 students who thought that on-line resources were most effective. Despite Donnelly (2000) Nicholl and Childs and Burn (2013)

advocating this method as the most effective way of developing SCK and PCK it is evident that this was not so popular with the students. This may be due to concerns of students' in approaching staff and highlighting their weaknesses as outlined in the literature review, Youens and Mc Carthy (2007).

The fifth part of this study focused on what the university could do to develop knowledge outside of specialism, question 6 (Appendices 1 and 5, Surveys 1 and 2)

Prior to PTE 1, nine students proposed that subject content lessons taught by university tutors would be beneficial. This increased to thirteen students after PTE 1.

Prior to PTE 1, nine students proposed that subject lessons by their peers would be beneficial. This remained constant at nine students after PTE 1.

In addition, prior to PTE1 one student proposed that help with practical work would be beneficial. After PTE1 two students reported that help with creating resources would be beneficial and one further student suggested that university assignment essays should be changed. These results will be considered as part of our departmental development plan with a view to providing more university based content lessons and peer help prior to PTE1.

Limitations.

This study is limited in that data was collected from only one teacher training institution, from a small group of students and within three months of entry to the course. The data collected was largely of a quantitative nature, a more robust study would have included qualitative data from semi structured interviews and focus group discussions with the students. This would have helped eliminate ambiguity, especially in the context of the confidence of students teaching inside and outside of specialism after PTE1 and also the chosen use of resources to facilitate teaching outside of specialism. Although I am confident that the responses from students' did directly reflect honest viewpoints collected at the time, a lack of time prevented other information such as reports or interviews with school mentors being used and analysed to support or contradict findings.

It has, nevertheless, provided valuable information as to the preconceptions and challenges that students experience when teaching outside of their subject specialism. This study has certainly provided sufficient information for the department in the university to reflect on current practice and adapt the current course in light of the findings of this study to benefit future PGCE students. These recommendations will be discussed in the next section.

Conclusion.

It is evident from the findings of this study that most of the respondents held clear concerns with regard to teaching outside of their subject specialism, especially prior to PTE1. Furthermore, they were able to provide insights as to the challenges they faced when teaching outside of their subject specialisms. It was surprising that even though over three quarters of students questioned thought that teaching outside of their subject specialism would have an effect on standards this was only observed to be the case for one student, and for only one lesson. However, a limitation of this study is that it does not explore how these challenges actually manifest themselves in the classroom.

Clearly, after completion of a term in school during PTE1 students' confidence in teaching outside of their subject area had increased with 61% now reporting that teaching outside their specialism would have an effect on standards, this was a drop of 17%. Further study would be needed to see if this trend would continue after completion of PTE2 and 3. However, what is not so transparent is why the chemistry teachers reported a drop in confidence in teaching their own subject after PTE1. This anomaly is mirrored by the responses of the chemists' when asked what topics needed developing with an increasing number reporting that they needed to further develop knowledge in their own subject. Further research could examine the backgrounds of student teachers entering the profession to ascertain whether or not the specialist knowledge of student teachers who have followed degree paths in subjects that were not strictly biology, chemistry or physics but rather contained elements of these sciences in their degree syllabuses such as sports science or material science degrees could have an effect.

Students' overwhelmingly favoured on line resources to research subject matter outside of their specialism with 67% noting that on line resources were the most effective. This contrasts with the work of many researchers (Mc Nicholl, Childs and Burn, 2013) who suggest that students' should be seeking knowledge and understanding from school based staff within their departments. However, as noted earlier students' may be apprehensive to directly approach school staff for fear of showing weaknesses. Mc Carthy and Youens (2013) note that from a very early stage students choose not to use them as development resources. What is clear is that students' found subject lessons from university tutors beneficial, along with being taught by peers whose specialisms were outside of their own. This could be implemented in future by focusing on a few key content areas in the key stage 3 syllabus (as this is what students' will be mainly teaching in PTE1) and for each area of study articulating what is needed to firstly understand each topic. Students could then consider how the content areas link to other scientific ideas and how they could transform them to make them accessible for pupils of differing ages and abilities. A learning progression framework could then be

planned to enable students to grasp the underlying principles of the individual learning areas. This is something that needs to be disseminated to the university tutors in the science PGCE department. More time needs to be devoted to these activities in the future, especially in the university based study prior to PTE1. This will form part of our yearly review and will inform our planning for the 2018 – 2019 academic year.

Whilst most students show more confidence in teaching outside their specialism after PTE1 the increase in confidence varied between students. This can be seen from the varying standard deviations in tables 7, 8 and 9 with physicists teaching biology topics showing the greatest variance. Unfortunately, it was beyond the work of this study to examine these issues in greater depth. Again, this is something that could be part of future research in the department.

It is true to say that little is known about the learning of science teachers' knowledge outside their disciplines when they start their training in schools (Childs and Mc Nicholl, 2007b). Further departmental research needs to be undertaken to explore this more widely. For example, this study could be expanded by shifting the focus from key stage 3 to key stage 4 to investigate the experiences and lesson outcomes of PGCE physics, chemistry and biology student teachers when teaching outside of their specialism in this key stage. A future departmental study could also include a greater study of teachers' experiences in school, particularly with regard to their engagement with their subject mentors and other departmental staff. Furthermore, the role of schemes of work (SOW) in helping student teachers to develop their SCK and PCK could be analysed, and also what makes a SOW particularly effective? Further research could also examine how student teachers learn SCK and PCK from textbooks and on-line materials and the effectiveness of resources designed for pupils when used by student teachers to develop subject knowledge outside of their specialisms.

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Appendices.

Appendix 1. Survey 1.

Enw / Name:

Arbenigedd pwnc (rhowch gylch) / Subject specialism (please circle)

Bioleg / Biology

Cemeg / Chemistry

Ffiseg / Physics

1) Ar hyn o bryd pa mor hyderus ydych i addysgu (rhowch farc allan o 10):

At the moment how confident are you in teaching (give a marc out of 10):

Bioleg / Biology / 10

Cemeg / Chemistry / 10

Ffiseg/ Physics / 10

2) Oes angen dysgu allan o'ch arbenigedd yng nghyfnod allweddol 3 yn PAP 1? Oes / Nac oes

In PTE 1 will you be teaching outside your specialism in key stage 3? Yes / No

3) Oes angen dysgu allan o'ch arbenigedd yng nghyfnod allweddol 4 yn PAP 1? Oes / Nac oes

In PTE 1 will you be teaching outside your specialism in key stage 4? Yes / No

4) Pa destunau sydd angen datblygu?

What topics need developing?

5) Pa adnoddau ydych chi'n defnyddio i ddatblygu eich gwybodaeth tu allan o'ch arbenigedd (rhowch gylch i bob un sy'n briodol).

What resources do you use to develop your subject knowledge outside your specialism (circle all that are relevant).

Gwerslyfrau / Textbooks

Gwybodaeth ar lein / Information on line

Eraill (rhowch fanylion) / Other (please specify)

6) Beth all y Brifysgol gwneud i wella eich gwybodaeth tu allan o'ch arbenigedd?

What could the University do to develop your knowledge outside your specialism?

7) Ydych chi'n meddwl bydd dysgu tu allan o'ch arbenigedd yn cael effaith ar safonau eich gwersi?

Ydw / Nac ydw.

Do you think that teaching outside your specialism will have an effect on the standard of your lessons?

Yes / No

8) Ydych chi'n hyderus i addysgu CA5 tu fewn eich arbinigedd? Ydw / Nac ydw

Are you confident to teach KS5 within your specialism?

Yes / No

Appendix 2. Anonymised university ethics form.

APPLICATION FOR ETHICAL APPROVAL

In order for research to result in benefit and minimise risk of harm, it must be conducted ethically. A researcher may not be covered by the University's insurance if ethical approval has not been obtained prior to commencement.

The University follows the OECD Frascati manual definition of **research activity**: “creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications”. As such this covers activities undertaken by members of staff, postgraduate research students, and both taught postgraduate and undergraduate students working on dissertations/projects.

The individual undertaking the research activity is known as the “principal researcher”.

Ethical approval is not required for routine audits, performance reviews, quality assurance studies, testing within normal educational requirements, and literary or artistic criticism.

Please read the notes for guidance before completing ALL sections of the form.

This form must be completed and approved prior to undertaking any research activity.

Please see Checklist for details of process for different categories of application.

SECTION A: About You (Principal Researcher)

Full Name:	Peter Joseph Lloyd				
Tick all boxes which apply:					
Member of staff:	☒	Student:	☒	Honorary research fellow:	☐

Faculty/School/Centre:	FEC University X				
Campus:	University X campus				
E-mail address:	Peter.lloyd@unix.ac.uk				
Contact Telephone Number:	078763XXXX				
For students:					
Student Number:	P152XXX	Undergraduate	☐		
Programme of Study:	MA Ed Independent study	Taught Postgraduate	☒		
Director of Studies/Supervisor:	Junnine Thomas - Walters	Research	☐		

SECTION B: Approval for Research Activity

Has the research activity received approval in principle? (please check the Guidance Notes as to the appropriate approval process for different levels of research by different categories of individual)		YES	☒	NO	☐
					Date
If Yes, please indicate source of approval (and date where known):	Research Degrees Committee		☐		
	Faculty Research Committee		☐		
	Other (write in) Angela Cooze		☒	3/10/2017	

Approval in principle **must** be obtained from the relevant source prior to seeking ethical approval.

SECTION C: External Ethical Guidance Materials

Please list the core ethical guidance documents that have been referred to during the completion of this form (including any discipline-specific codes of research ethics, and also any specific ethical guidance relating to the proposed methodology). Please tick to confirm that your research proposal adheres to these codes and guidelines.	
University X Code of ethics: Research Ethics & Integrity Code of Practice 2017-2020	☒
BERA (2011): ETHICAL GUIDELINES FOR EDUCATIONAL RESEARCH	☒
	☐

SECTION D: External Collaborative Research Activity

Does the research activity involve collaborators outside of the University?	YES	☐	NO	☒
If Yes, please provide the name of the external organisation and name and contact details for the main contact person:				
Institution				
Contact person name				
Contact person e-mail address				

Where research activity is carried out in collaboration with an external organisation

Does this organisation have its own ethics approval system?	YES	☐	NO	☒
If Yes, please attach a copy of any final approval (or interim approval) from the organisation				

SECTION E: Details of Research Activity

Indicative title:	Does teaching outside of subject specialism affect the quality of the lessons.		
Proposed start date:	1/12/17	Proposed end date:	1/3/18
Purpose of research activity (including aims and objectives) Outline the purpose, aims and objectives of the research activity, including key research questions. Show briefly how existing research has informed the proposed activity and explain what the research activity will add and how it addresses an area of importance. (Maximum 300 words)			
• Following the publication of Professor Graham Donaldson's Successful Future the new curriculum in Wales will be grouped into 4 areas of learning. • In the future teaching staff will be required to teach all of the subjects in the designated area of learning. • This research activity will analyse the teaching standards of postgraduate students undertaking the secondary Post Graduate Certificate of Education (PGCE) at University X • There are currently 20 students in the science faculty studying for separate PGCE qualifications in biology, chemistry and physics. • As part of the PGCE qualification students are observed teaching by mentors in partnership schools and by members of staff at the University. Their lessons are then graded on one of four levels, excellent, good, adequate or unsatisfactory. • All teachers will be expected to teach science lessons in schools regardless of their specialist discipline. • The research will examine if the grading of lessons is affected when student teachers teach lessons that are outside their areas of expertise. (this box should expand as you type)			

Proposed methods

Provide a brief summary of all the methods that **may** be used in the research activity, making it clear what specific techniques may be used. If methods other than those listed in this section are deemed appropriate later, additional ethical approval for those methods will be needed. (Maximum 600 words)

The progress of student teachers is monitored by mentors in their placement schools and also by members of staff from the university. Observed lessons are graded and the results recorded on the University X website. Participants (PGCE student teachers) will be informed that the data will be recorded in the usual way that lessons are assessed. No additional data collection will take place other than the usual practice. The results of the observed lessons on the University X website will be anonymised and transferred to an Excell spreadsheet that will be kept on a password protected USB memory device. The raw data will be analysed by the researcher to determine if the grading of lessons is affected when student teacher teach outside their specialist areas.

Student teachers will also be asked to complete a questionnaire to assess whether their understanding of subjects outside their specialist areas has been enhanced as a result of their first teaching placement.

(this box should expand as you type)

Location of research activity Identify all locations where research activity will take place.
University X (this box should expand as you type)
Research activity outside of the UK If research activity will take place overseas, you are responsible for ensuring that local ethical considerations are complied with and that the relevant permissions are sought. Specify any local guidelines (e.g. from local professional associations/learned societies/universities) that exist and whether these involve any ethical stipulations beyond those usual in the UK (provide details of any licenses or permissions required). Also specify whether there are any specific ethical issues raised by the local context in which the research activity is taking place, for example, particular cultural sensitivities or vulnerabilities of participants.
N/A (this box should expand as you type)

SECTION F: Scope of Research Activity

Will the research activity include:	YES	NO
Use of a questionnaire or similar research instrument?	☒	☐
Use of interviews?	☐	☒
Use of diaries?	☐	☒
Participant observation with their knowledge?	☒	☐
Participant observation without their knowledge?	☐	☒

Use of video or audio recording?	☐	☒
Access to personal or confidential information without the participants' specific consent?	☐	☒
Administration of any questions, test stimuli, presentation that may be experienced as physically, mentally or emotionally harmful / offensive?	☐	☒
Performance of any acts which may cause embarrassment or affect self-esteem?	☐	☒
Investigation of participants involved in illegal activities?	☐	☒
Use of procedures that involve deception?	☐	☒
Administration of any substance, agent or placebo?	☐	☒
Working with live vertebrate animals?	☐	☒
Other primary data collection methods, please explain in this box The grading of lessons will be entered onto the University X website data base in the usual way that PCGE students are graded.	☒	☐

If NO to every question, then the research activity is (ethically) low risk and **may** be exempt from **some** of the following sections (please refer to Guidance Notes).

If YES to any question, then no research activity should be undertaken until full ethical approval has been obtained.

SECTION G: Intended Participants

Who are the intended participants:	YES	NO
Students or staff at the University?	☒	☐
Adults (over the age of 18 and competent to give consent)?	☒	☐
Vulnerable adults?	☐	☒
Children under 18?	☐	☒
Prisoners?	☐	☒
Young offenders?	☐	☒
Those who could be considered to have a particularly dependent relationship with the investigator or a gatekeeper?	☐	☒
People engaged in illegal activities?	☐	☒
Others (please identify):	☐	☒

Participant numbers and source

Provide an estimate of the expected number of participants. How will you identify participants and how will they be recruited?

20 participants. The participants will all be current postgraduate students on the PGCE Biology, Chemistry and Physics courses.

(this box should expand as you type)

Information for participants:	YES	NO	N/A
Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	☒	☐	☐
Will you tell participants that their participation is voluntary?	☒	☐	☐
Will you obtain written consent for participation?	☒	☐	☐
Will you explain to participants that refusal to participate in the research will not affect their treatment or education (if relevant)?	☒	☐	☐
If the research is observational, will you ask participants for their consent to being observed?	☒	☐	☐

Will you tell participants that they may withdraw from the research at any time and for any reason?	☒	☐	☐
With questionnaires, will you give participants the option of omitting questions they do not want to answer?	☒	☐	☐
Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☒	☐	☐
Will you debrief participants at the end of their participation, in a way appropriate to the type of research undertaken?	☒	☐	☐
If NO to any of above questions, please give an explanation			
(this box should expand as you type)			

Information for participants:	YES	NO	N/A
Will participants be paid?	☐	☒	☐
Is specialist electrical or other equipment to be used with participants?	☐	☒	☐
Are there any financial or other interests to the investigator or University arising from this study?	☐	☒	☐
Will the research activity involve deliberately misleading participants in any way, or the partial or full concealment of the specific study aims?	☐	☒	☐
If YES to any question, please provide full details			
(this box should expand as you type)			

SECTION H: Anticipated Risks

Outline any anticipated risks that may adversely affect any of the participants, the researchers and/or the University, and the steps that will be taken to address them.
Risks to participants
For example: emotional distress, financial disclosure, physical harm, transfer of personal data, sensitive organisational information
Transfer of personal raw data from the University X website database to the researcher's excel database could result in personal information being lost or copied. It is unlikely that this will happen as data transfer will only be undertaken at University X campus and the USB memory stick will be password protected.
Questions could be asked that would make participants uncomfortable in their ability to teach out of their specialist area. However student will be able to opt out of the questionnaire at any time.
Risks to participants during lesson observation – possible increase of stress on participants, however the risk of increased stress due to this research is minimal as lesson observations are a statutory part of participants gaining qualified teacher status.
(this box should expand as you type)
If research activity may include sensitive, embarrassing or upsetting topics (e.g. sexual activity, drug use) or issues likely to disclose information requiring further action (e.g. criminal activity), give details of the procedures to deal with these issues, including any support/advice (e.g. helpline numbers) to be offered to participants. Note that where applicable, consent procedures should make it clear that if something potentially or actually illegal is discovered in the course of a project, it may need to be disclosed to the proper authorities
N/A
(this box should expand as you type)
Risks to investigator

For example: personal safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest

Transfer of personal data from the University X website database to the researcher's excel database could result in personal information being lost or copied. It is unlikely that this will happen as data transfer will only be undertaken at University X campus and the USB memory stick will be password protected.

(this box should expand as you type)

University/institutional risks

For example: adverse publicity, financial loss, data protection

Loss or transfer of student's personal data to third parties could result in a breach of data protection policy. It is unlikely that this will happen as data transfer will only be undertaken at University X campus and the USB memory stick will be password protected.

(this box should expand as you type)

Adverse outcomes

List measures put in place to limit any adverse effects or outcomes of research activity where appropriate. Include any emergency protocols.

All data transferred from the University X website data base will be anonymised prior to being stored on the researcher's excel spreadsheet. The spreadsheet will be stored on a USB device that is password protected.

Questionnaires will be structured so that they do not probe into details of any deficiency in participants' subject knowledge.

(this box should expand as you type)

Disclosure and Barring Service			
If the research activity involves children or vulnerable adults, a Disclosure and Barring Service (DBS) certificate must be obtained before any contact with such participants.	YES	NO	N/A
Has a DBS certificate been obtained?	☐	☐	☒

SECTION I: Feedback, Consent and Confidentiality

Feedback

What feedback will be provided to participants, how will this be done and when?

Feedback on lesson outcomes will be given to the students in the usual way following the guidelines on the University X website i.e. verbally within 24 hours and in writing within 72 hours.

(this box should expand as you type)

Informed consent

Describe the arrangements to inform potential participants, before providing consent, of what is involved in participating. Describe the arrangements for participants to provide full consent before data collection begins. If gaining consent in this way is inappropriate, explain how consent will be obtained and recorded.

Participants will be informed of the nature of the research i.e. that they will be anonymised and that only a comparison of data collected within and outside their specialist subject area will be analysed. Participants will be asked to complete a consent form to participate in the task.

Only the data of participants that agree to full consent will be used in the research and participants will be able to withdraw themselves and any data already collected from the research at any time.

(this box should expand as you type)

Confidentiality / Anonymity

Set out how anonymity of participants and confidentiality will be ensured in any outputs. If anonymity is not being offered, explain why this is the case.

Participant's names will be removed as data is transferred from the University X website. It is only necessary for the researcher to be aware of the subject discipline of the participants therefore participants will be anonymised.

(this box should expand as you type)

SECTION J: Data Protection and Storage

In completing this section refer to the University's Research Data Management Policy and the extensive resources on the University's Research Data Management web pages (<http://uwtsd.ac.uk/library/research-data-management/>).

	YES	NO
Does the research activity involve personal data (as defined by the Data Protection Act)?	☒	☐
If YES, provide a description of the data and explain why this data needs to be collected:		
The only data recorded would be the lesson grade and specialist subject area. Information will be anonymised as participants' names or other personal information will not be transferred from the University X website. (this box should expand as you type)		
Does it involve sensitive personal data (as defined by the Data Protection Act)?	☐	☒
If YES, provide a description of the data and explain why this data needs to be collected:		
(this box should expand as you type)		

Will the research activity involve any of the following activities:	YES	NO
Electronic transfer of data in any form?	☒	☐
Sharing of data with others at the University?	☐	☒
Sharing of data with other organisations?	☐	☒
Export of data outside the European Union or importing of data from outside the UK?	☐	☒

Use of personal addresses, postcodes, faxes, emails or telephone numbers?	☐	☒
Publication of data that might allow identification of individuals?	☐	☒
Use of data management system?	☒	☐
Data archiving?	☐	☒
If YES to any question, please provide full details, explaining how this will be conducted in accordance with the Data Protection Act (and/or any international equivalent):		
(this box should expand as you type)		

Will the research activity involve storing personal data on one of the following:	YES	NO
Manual files (i.e. in paper form)?	☐	☒
University computers?	☐	☒
Private company computers?	☐	☒
Home or other personal computers?	☐	☒
Laptop computers/ CDs/ Portable disk-drives/ memory sticks?	☒	☐
“Cloud” storage or websites?	☐	☒
Other – specify:	☐	☒
For all stored data, explain the measures in place to ensure data confidentiality, including details of password protection, encryption and anonymisation:		
Participants will be anonymised prior to data storage. The memory stick will be stored in a locked filing cabinet and will be password protected. (this box should expand as you type)		

List all who will have access to the data generated by the research activity:
The researcher only. However, the Senior mentor in the school will have access to the original raw data as per usual policy. (this box should expand as you type)
List who will have control of, and act as custodian(s) for, data generated by the research activity:
The researcher only. (this box should expand as you type)
Give details of data storage arrangements, including where data will be stored, how long for, and in what form. Will data be archived – if so how and if not why not.

Data will be stored on a password protected USB memory and will be erased on completion of the research project by formatting the USB memory.

(this box should expand as you type)

SECTION K: Declaration

The information which I have provided is correct and complete to the best of my knowledge. I have attempted to identify any risks and issues related to the research activity and acknowledge my obligations and the rights of the participants.

In submitting this application I hereby confirm that I undertake to ensure that the above named research activity will meet the University's [Research Ethics and Integrity Code of Practice](#)

Signature of applicant:

Date: 16/10/2017

For students:

Director of Studies/Supervisor:	J M Thomas-Walters
Signature:	
Date:	19/10/17

For staff:

Head of School/Assistant Dean:	
Signature:	
Date:	

Checklist: Please complete the checklist below to ensure that you have completed the form according to the guidelines and attached any required documentation:

☒	I have read the guidance notes supplied before completing the form.
☒	I have completed ALL RELEVANT sections of the form in full.

☒	I confirm that the research activity has received approval in principle
☐	I have attached a copy of final/interim approval from external organisation (where appropriate)
☒	I understand that it is my responsibility to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice.
☒	I understand that before commencing data collection all documents aimed at respondents (including information sheets, consent forms, questionnaires, interview schedules etc.) must be confirmed by the DoS/Supervisor, module tutor or Head of School.

RESEARCH STUDENTS AND STAFF ONLY

All communications relating to this application during its processing must be in writing and emailed to pgresearch@uwtsd.ac.uk , with the title 'Ethical Approval' followed by your name.

You will be informed of the outcome of your claim by email; therefore **it is important that you check your University and personal email accounts regularly.**

STUDENTS ON UNDERGRADUATE OR TAUGHT MASTERS PROGRAMMES should submit this form (and receive the outcome) via systems explained to you by the supervisor/module leader.

This form is available electronically from the Academic Office web pages:

Application Process

Appendix 3. Information for participants.

Gwaith ymchwil.

Ydy dysgu tu allan o'r arbinedd yn cael effaith ar safonau.

Pwrpas yr ymchwil.

Gyda newidiadau 'Donaldson' ar y gorwel mae'r ymchwilydd am ddarganfod:

- beth yw pryderon myfyrwyr sy'n dysgu tu allan o'i arbinedd.
- beth mae'r prifysgol yn gallu gwneud i hwyluso'r broses.
- ydy dysgu tu allan o arbinedd yn cael unrhyw effaith ar safonau.

Yn sgil yr ymchwil fe fydd y Brifysgol yn gobeithio gwella darpariaeth.

Fe fydd yr ymchwil yn casglu data o arolwg yn y lle gyntaf, ac wedyn o'r gwefan SWWCTE. Fe fydd y data yn cael eu trosglwyddo i gof USB yn hollol anhysbys.

Fe fydd y data yn cael eu dadansoddi er mwyn ceisio dod o hyd i atebion i'r cwestiynau uchod.

Ar ol gorffen yr ymchwiliad fe fydd y data i gyd yn cael eu dileu.

Fe fydd hawl i gyfranwyr tunn allan o'r ymchwil ar unrhyw adeg a fe fydd unrhyw ddata cysylltiedig yn cael eu dileu.

Oherwydd natur yr ymchwil ni fydd yn rhagfynegu unrhyw niwed i cyfanwyr / ymchwilwr.

Research.

Does teaching outside of subject specialism have an adverse effect on standards?

Purpose of study.

With the new 'Donaldson' curriculum on the horizon the researcher is investigating:

- What are students' concerns with regard to teaching outside their subject specialism?

- What can the University do to facilitate the process?
- Does teaching outside of specialism have an effect on standards?

In light of the research the University hopes to improve future provision.

Initial data will be captured by a survey and subsequent data will be copied to a USB stick from the SWWCTE website, all data will be anonymised.

The data will be analysed in order to provide answers to the above questions.

On completion of the research all data will be erased.

Participants can withdraw at any time and any data collected will be erased.

Because of the nature of the research there are no significant risks envisaged to either the participants or the researcher.

Appendix 4. Consent form.

RESEARCH ETHICS: CONSENT FORM

Full title of Project: Does teaching outside of subject specialism have an adverse effect on standards?

Pete Lloyd. Lecturer. University X, South Wales.

Please Initial Box

- | | | |
|----|--|--------------------------|
| 1. | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | ☐ |
| 2. | I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. | ☐ |
| 3. | I agree to take part in the above study. | ☐ |

Name of Participant	Date	Signature

Pete Lloyd

Name of Researcher

Date

Signature

Appendix 5. Survey2.

Enw / Name:

Arbenigedd pwnc (rhowch gylch) / Subject specialism (please circle)

Bioleg / Biology

Cemeg / Chemistry

Ffiseg / Physics

1) Ar hyn o bryd pa mor hyderus ydych i addysgu (rhowch farc allan o 10):

At the moment how confident are you in teaching (give a marc out of 10):

Bioleg / Biology / 10

Cemeg / Chemistry / 10

Ffiseg/ Physics / 10

2) Oes angen dysgu allan o'ch arbenigedd yng nghyfnod allweddol 3 yn PAP 1? Oes / Nac oes

In PTE 1 will you be teaching outside your specialism in key stage 3? Yes / No

3) Oes angen dysgu allan o'ch arbenigedd yng nghyfnod allweddol 4 yn PAP 1? Oes / Nac oes

In PTE 1 will you be teaching outside your specialism in key stage 4? Yes / No

4) Pa destunau sydd angen datblygu?

What topics need developing?

5) Pa adnoddau ydych chi'n defnyddio i ddatblygu eich gwybodaeth tu allan o'ch arbenigedd (rhowch gylch i bob un sy'n briodol).

What resources do you use to develop your subject knowledge outside your specialism (circle all that are relevant).

Gwerslyfrau / Textbooks

Gwybodaeth ar lein / Information on line

Trafodaethau gyda staff yn yr adran wyddoniaeth / Discussions with science department staff

Pa un o'r uchod yw'r mwyaf effiethlon? / Which of the above is the most effective?

6) Beth all y Brifysgol gwneud i wella eich gwybodaeth tu allan o'ch arbenigedd?

What could the University do to develop your knowledge outside your specialism?

7) Ydych chi'n meddwl bydd dysgu tu allan o'ch arbenigedd yn cael effaith ar safonau eich gwersi?

Ydw / Nac ydw.

Do you think that teaching outside your specialism will have an effect on the standard of your lessons?

Yes / No

8) Ydych chi'n hyderus i addysgu CA5 tu fewn eich arbinigedd? Ydw / Nac ydw

Are you confident to teach KS5 within your specialism?

Yes / No

Appendix 6. Lesson observation data capture, example.

	A	B	C	D	E	F	G	H	I
1									
2		Specialism						Mean inside specialism	Mean outside specialism
55	Student 11	Physics	Observation	A	B	C	D		
56			Topic	Physics	Biology	Physics	Physics		
57			Grading	3,2,3,3,	2,3,2,2,	3,2,2,2,	3,2,2,2		
58			Total Mark	11	9	9	9	9.7	9
59									
60	Student 12	Physics	Observation	A	B	C	D		
61			Topic	Chemistry	Physics	Biology	Physics		
62			Grading	3,2,2,2	3,2,2,2	3,2,2,3	3.2.2.3.		
63			Total Mark	9	9	10	10	9.5	9.5
64									
65	Student 13	Physics	Observation	A	B	C			
66			Topic	Physics	Chemistry	Physics			
67			Grading	3,3,2,3,	4,3,4,3,	3,3,2,3,			
68			Total Mark	11	14	11		11	14