Gall, M. (2016). TPACK and Music Teacher Education. In A. King, E. Himonides, & A. Ruthmann (Eds.), *The Routledge Companion to Music, Technology, and Education* (pp. 305-318). Routledge. https://www.taylorfrancis.com/books/e/9781317415138/chapters/10.4324%2F9781315686431-38

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TPACK and Music Teacher Education

Background

I have been researching music technology in schools and teacher education since 2000 when I led the music team within a large-scale project that explored teachers' use of technology across seven school subjects.[1] As part of our research, the music team used Shulman's Pedagogical Content Knowledge (PCK) framework (1987) to further our thinking about in-service teachers' work in classrooms with music technology, and also as a lens through which to consider teachers' perceptions of technology in school music (Gall & Breeze, 2007). At the time I was not aware of developments by Pierson (2001) who, as part of a discussion on ways in which technology (T) impacts upon teaching, transformed the model to include Technological Pedagogical Content Knowledge (TPCK). From 2006 to 2009 I also engaged in an international project, part of which included the development of a set of descriptors to indicate the musical competences one might expect of music educators across Europe.[2]

At the University of Bristol I lead the one-year Postgraduate Certificate of Education (PGCE) Secondary Music course for pre-service teachers. My research into school music and technology has impacted upon my thinking and organisation of the course, of which ICT is a key aspect. Aside from drawing upon student teachers' feedback to further develop the course, I have carried out empirical research on their perceptions and uses of music technology whilst on teaching practice in schools (Gall, 2013), and within university sessions (Gall & Breeze, 2014). Recently I have re-engaged with the TPACK model[3] and, at the start of the academic year 2013-2014 (September), I began a three-year action research study that:

i)   has involved the development of a conceptual framework for music teaching and technology, which builds upon ideas related to both the PCK (Shulman, 1987) and TPACK models (Pierson, 2001; Mishra and Koehler, 2006);

ii)   is exploring the introduction of this model into the University of Bristol's PGCE Music course.

iii)   aims to support my development of the course through consideration of the novice music teachers' perceptions of their professional growth relating to the use of ICT for learning and teaching, both within university sessions and whilst on teaching practice in schools.

There is insufficient space within this chapter for consideration of both the conceptual framework for music teaching and detail of the action research study, so the main focus will be on the former. Aware that an understanding of historical, cultural and educational context is vital to any discussion of learning and teaching, I begin by outlining the position of technology in school music and in music pre-service education. This is followed by an account of the development of the TPACK model,

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[1] The InterActive Education Project (2000-2004). See http://www.esrc.ac.uk/my-esrc/grants/L139251060/read

[2] Although this did not include a strong focus on technology. See: http://menet.mdw.ac.at/menetsite/english/aboutmenet.html?m=0&c=0&lang=en

[3] Technology and Pedagogical Content Knowledge (TPCK) changed into TPACK in 2008 (Thompson, 2008). As such, I will use both terms according to the date of the work under discussion.

after which I explain my new model related to music education in England, which I discuss, principally, in relation to initial teacher education. I then outline my approach to the action research study and provide some initial findings. The chapter ends with further ideas for use of the music conceptual framework in future teacher education work.

Secondary School Music and Teacher Education in England 1986-2014[4]
The first governmental order related to technology - that pupils should "use ICT to capture, change and to combine sounds" (DfEE/QCA, 1999, 2/5d) - came about some years after the introduction of the first ever music National Curriculum for England and Wales (DES, 1991). The latter was significant in including composition as one of the three experiential modes which were, and to this day remain, at the heart of the English National Curriculum[5], the other two being performing and listening (with appraising/evaluating often linked to listening). Today's English National Curriculum (Gov.UK, 2013) is also similar to the first (DES, 1991) in that it does not prescribe content. As such, almost every secondary school music curriculum for 11-14 year olds is different.

Early changes to Music for 14-16 year olds also paved the way for the introduction of technology: the new General Certificate of Secondary Education (GCSE) school music examination syllabus, of 1986, introduced composition as a requirement, and pupils with access to equipment began to explore the creative possibilities offered by music computer software (Desmond, 2002). At this time, older pupils aged 16-18 were already composing using computers and stand-alone multi-track tape recorders, as part of the Advanced level (A level) final school examination (Philpott & Carden-Price, 2001). However, in 1995, the Edexcel examination board[6] offered a completely new A level entitled *Music Technology* which enabled pupils to focus their work on technological aspects of music making (Kwami, 2001). Since this time all boards have made adaptations to their GCSE and A level syllabi such that, in 2014, at both levels, sequencers, recording software, samplers and record decks are permitted for composing, and for solo and ensemble performing (Sullivan *et al.*, 2009). Furthermore, examination courses in music technology are becoming more and more popular (Ofsted, 2012) and varied (Evans, 2012). In contrast, opportunities for younger secondary pupils to engage with music technology in school are limited (Ofsted, 2012). The most recent triennial government report on music in schools noted that the use of music technology "was inadequate or non-existent" in over a third of the 90 secondary schools that were inspected (*ibid.*, p.4).

In England, in 2014, those wishing to train to become secondary music teachers often arrive at their one-year PGCE[7] pre-service teacher education course having completed a 3-year undergraduate degree in music as a single subject, or with other subjects. However, these degree courses differ greatly[8] and may have no links at all with

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[4] Throughout I write English because the education systems and school music are not the same in all countries of the UK.
[5] Which now differs slightly to that of Wales.
[6] Schools choose from three government regulated examination boards - *AQA, Edexcel* and *OCR* - which set their own syllabi and examinations.
[7] It is termed 'one-year' but, in reality, it is about 10 months in length.
[8] Trainees have come to the University of Bristol's teacher education course from undergraduate studies focussing on Classical Music, Jazz Performance, Music Technology, and Performing Arts, to mention only a few.

education (Crow, 2008). To qualify to teach in a maintained school, one must gain Qualified Teacher Status (QTS) by demonstrating competence in areas prescribed by the government (Gov.UK, 2011).[9] Passing the PGCE course leads to QTS. In 2002, detailed technological requirements for each school subject were specified (TTA, 2002), but the latest teaching standards framework makes no mention of technology (Gov.UK, 2011). Thus, the initial teacher education provider[10] decides what is covered, and when and how ICT is included in the course. During the pre-service teacher education period, student teachers spend at least two thirds of their time in schools (NCTL, 2015). As might be expected, music departments within these vary considerably in terms of the technological facilities they possess, the music curriculum that they have devised for 11-14 year olds, and the examination syllabi that they offer children aged 14-16 and 16-18.

Within the University of Bristol initial teacher education course for secondary music we place a very strong emphasis on music technology. The novice teachers are involved in workshops for skills development, and in discussions about pedagogy. They also complete formal assignments which assess their skills in sequencing; and their ability to design, teach and reflect upon units of work for 11-14 year olds that include the use of technology to support students' musical learning.

The Development of PCK and TPACK
The PCK theoretical construct was first introduced by Shulman. He provided a taxonomy of knowledge bases in which he classified the types of comprehension required of teachers for promoting student learning:

● Content Knowledge;
● General Pedagogical Knowledge (the broad principles and strategies of classroom management and organisation which appear to transcend the subject matter);
● Curriculum Knowledge (the materials and programs used by teachers as "tools of the trade");
● Pedagogical Content Knowledge (an amalgam of content and pedagogy);
● Knowledge of Students (including their characteristics);
● Knowledge of Educational Contexts (the workings of the group, classroom or school; regional and national situations; the character of communities);
● Knowledge of Educational Ends (purposes and values; historical and philosophical roots of teaching and learning of the subject) (adapted from Shulman, 1987, p.8).

What was novel to educational debate at this time was the notion of Pedagogical Content Knowledge (PCK): the special amalgam of content and pedagogy. This was deemed distinct from a consideration of content and pedagogy separately: Shulman proposed that PCK includes awareness of which teaching methods suit the content, and of pedagogical approaches to, and interpretation of, subject matter in order to make it comprehensible to learners (*ibid.*). Since 1987, PCK has been used, broadly, within education, including research on initial teacher education (Cochran, *et al*., 1993; Loughran *et al*., 2008).

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[9] However, one is only classified as 'fully' qualified after successful completion of a further 12-month's work within a school.
[10] Provider is the term used to denote the formal PGCE partnership that exists between higher education institutions and schools.
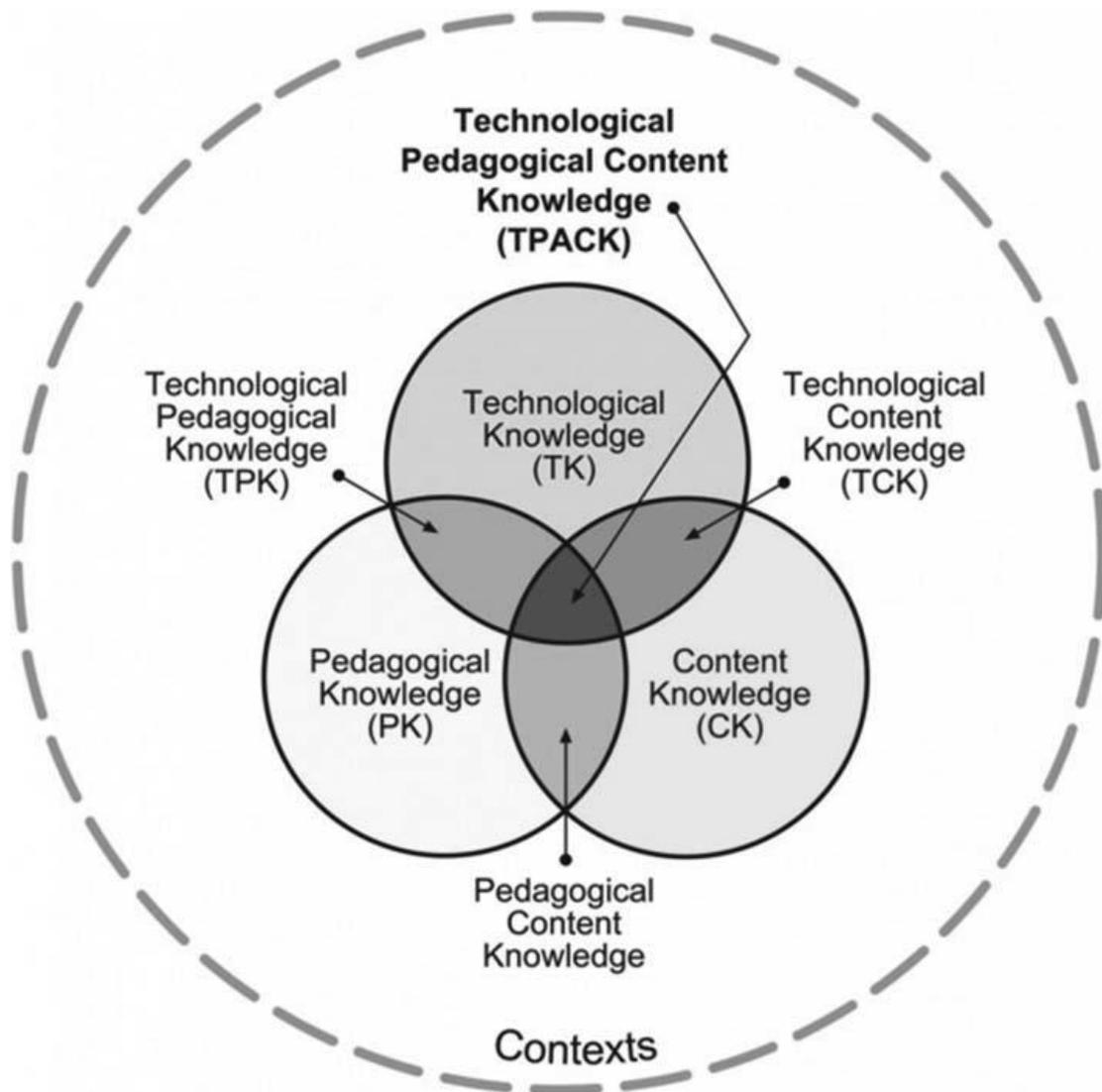
Figure 1. Technical Pedagogical Content Knowledge (TPACK). Reproduced by permission of the publisher, © 2012 by tpack.org

The arrival of computers, inevitably, led to debate about the effect of technologies on learning and teaching. Pierson (2001) was first to modify the framework to include the concept of Technological Pedagogical Content Knowledge (TPCK) (p.427). Mishra and Koehler further developed thinking around the model, the detail of which is presented in their article of 2006. They believed it important to move away from a focus upon technological knowledge (TK) in itself, and to "identify important components of teacher knowledge that are relevant to the thoughtful integration of technology in education"(p.1044). As such, in addition to Pedagogical Content Knowledge, they were interested in exploring Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and, in particular, Technological Pedagogical Content Knowledge, TPCK. (See figure 1.)

This framework has been used extensively within teaching, across many subjects (Baran *et al*., 2011; Chai *et al.,* 2013), with some educators making adaptations to better represent the context of their work (Doering *et al.*, 2009). However, whilst educators across the globe have been considering music teachers' professional

development (de Baets & Buchborn, 2014), and ways in which technology impacts upon musical learning (Gall *et al.*, 2012), the dearth of literature on TPACK and music has been noted (Chai *et al.,* 2013). Some in-service music teacher professional development workshops in the USA include a consideration of TPACK (Just & Pyrek, 2013) but only one researcher has produced any articles on the subject; Bauer, writing about music teaching and technology in the USA, uses the same framework as Pierson (2001) and Mishra and Koehler (2006). He discusses the model, suggesting ways in which the different TPACK domains apply to music education (2010a, 2010b, 2012, 2014). He also presents findings from an empirical study of experienced US music teachers' perceptions of their own teaching related to the TPACK components.

Whilst Bauer's work begins to offer a deeper insight into the intricacies of *music* teaching with technology, his work is located within a very different music education system to my own: in the USA, most schools place a strong focus on ensemble (performance) work (Greher, 2015 forthcoming). As such, for my own thinking and work it was crucial to consider TPACK within the context of music teaching in England.

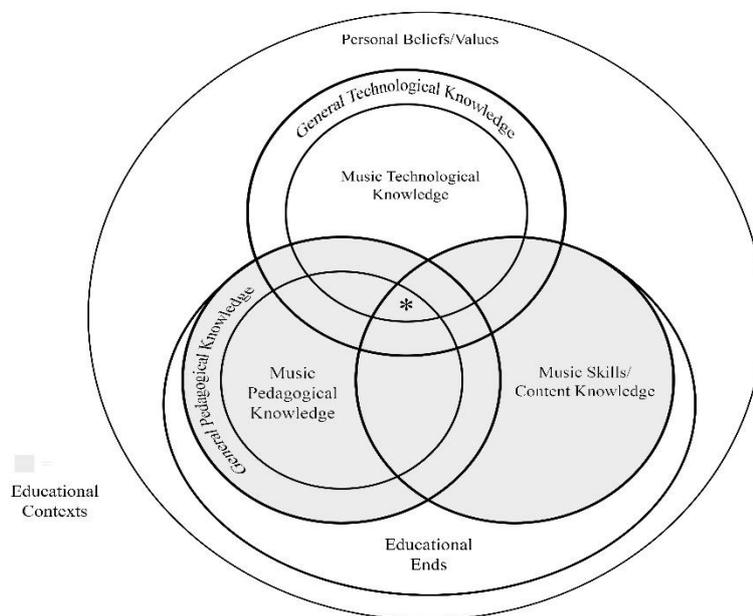**TPACK in Secondary Music Initial Teacher Education in England = TPACK and More[11]**

Figure 2: New Music Education Conceptualisation of TPACK.

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[11] In the discussion that ensues, I relate my thinking to initial teacher education; however, it is self-evident that this is often also applicable to the work of experienced music teachers.
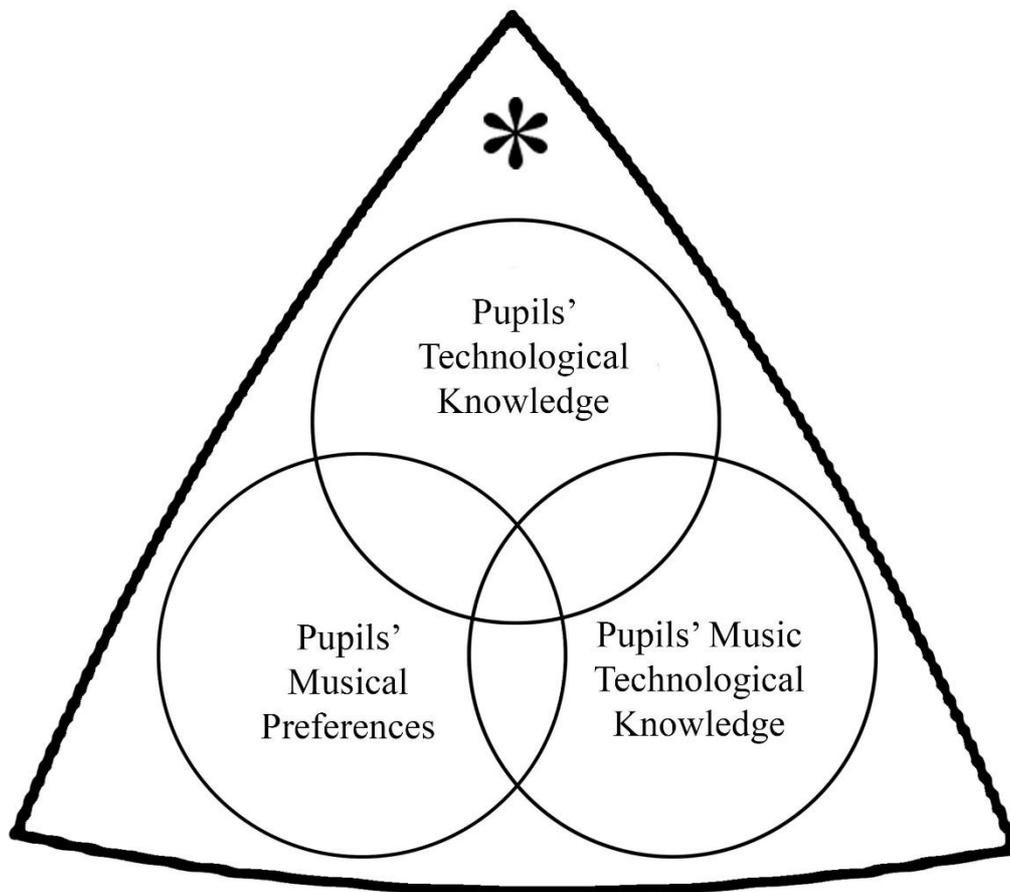
Figure 3: Section * from Figure 2: Detail of the Central Intersection of the Domains.

Figures 2 and 3 above present the adaptations I have made to the TPACK model of Mishra and Koehler (2006) which include developments related to the domains of Technological Knowledge and Pedagogical Knowledge. I have also brought back into the frame some of Shulman's categories of 1987, which have often lacked a sharp focus in research related to TPCK/TPACK: Knowledge of Educational Contexts, Knowledge of Pupils and Knowledge of Educational Ends.

One alteration that I have made is to draw a distinction between General Pedagogical Knowledge and Music Pedagogical Knowledge. As in all subjects, novice teachers grapple with general pedagogies such as how to question pupils. However, the pre-service music teachers with whom I work often complain that they have more to learn than PGCE trainees from other subjects because classroom music comprises many different musical activities and each requires a different pedagogy specific to music teaching. For example, classroom orchestra or extra-curricular ensembles, that are mainly teacher-led, require very different pedagogical approaches to composing activities in which the teacher best acts as a facilitator of pupil learning.

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Another alteration I have made to the commonly-used TPACK model is to subdivide Technological Knowledge into General Technological Knowledge and Musical Technological Knowledge. It seems to me that, there is a complexity to this domain for trainee music teachers that may not exist in other school areas. In subjects that are largely facts or ideas-based it appears that the main types of technology used are 'general' ones, such as the Internet, word processing packages, etc. Not only are these quite simple to operate but they are also commonly used outside school. In school music, 'general' forms of technology - such as the internet as a means of accessing a wide range of music, for acquiring chord sequences or words of songs, etc. - are useful; however, in English music classrooms, because of the emphasis placed on practical work, technologies to support creative work are even more important. Currently, computer software packages for recording, sequencing and notation purposes are the most common in English schools. Such technologies, in themselves, can be complex and take time for adults to master. However, an even wider range of technologies is now permitted for use within the school examination systems (Sullivan *et al.*, 2009) as well as being offered for study at degree level (Clark, 2014)[12]. As such, gaining awareness of / competence in using these constitutes considerable additional work for music trainee teachers. Furthermore, the type of cross-arts projects that model 'real-world' experiences, which are seen to be essential to good education (Ofsted, 2009), may well require that a range of technologies - both music and 'general/other' - be used within music lessons.[13]

I now move to a consideration of Knowledge of Educational Contexts, originally a category identified as significant by Shulman (1987). In some subjects, one might consider this as surrounding all other domains. However, some English schools now have a music technician within their department: typically someone who is highly skilled in the operational aspects of music technologies - and possibly also working as a 'professional musician' - whose main role is to ensure that the equipment is in working order. In certain situations, these 'technicians' are used as teaching 'assistants' given specific tasks such as working with small groups of pupils to introduce them to a music technology. Whilst such staff will have highly developed technological knowledge (often general as well as musical), it is possible that they have a limited understanding of what constitutes school music, locally and nationally, and limited pedagogical skills. My conceptualisation is important because I have known school managers to bring in such personnel as sole tutors for music technology examination classes and, unsurprisingly, these tutors either have had significant problems with their work or have required a huge amount of support from other departmental staff. In terms of teacher education, when planning lessons that include technology, trainee teachers on school placements in departments lucky enough to have a music technician, should be encouraged to consider ways in which they can capitalise on the strengths that the technician can bring to classroom work, whilst at the same time being mindful of the knowledge and skills that s/he may lack.

Figure 3, which represents the middle intersection - the overlap of the three domains in figure 2 - illustrates my further thinking about the area that Pierson (2001), Mishra

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[12] Clark announces that beatboxing is being introduced into a course at the Guildhall School of Music and Drama (music conservatoire).

[13] One example, now common in English secondary schools, is the use of both video and sequencing software for creative work within 'music and film' projects (Gall *et al.,* 2009).

and Koehler (2006) and Bauer (2009) label TPACK/TPCK.[14] Shulman included knowledge of the pupils as one of his seven knowledge bases but Mishra and Koehler only make mention of these within their description of the TPACK domain (*ibid*., p,1029). For me, it is important that 'pupils' take a central position within any conceptualisation of education; without this there is a danger that the focus remains on teaching rather than on pupil learning, hence, my additions to the framework as presented in figure 3. Moreover, in school Music classes, there exist huge differences between the experiences/ instrumental/ vocal skills of pupils resulting from the fact that some have had more immersion in music than others in their lives outside school and/ or through individual instrumental/ singing lessons (Lamont, 2002). So too in relation to ICT: over time, there has been a move from the notion that all young children are "digital natives" (Prensky, 2001, p.1) to a more nuanced understanding of the diversity of competence and confidence that exists, largely because access to technology outside school varies from pupil to pupil (Bennett *et al*., 2008). Awareness of pupils' individual technological skills is essential if a teacher is to design activities suited to all those in the class. Additionally, within my conceptual framework, I make a distinction between pupils' *general* technological skills and their *music* technological skills; see figure 2. It is axiomatic that some pupils may be competent and confident with general ICT skills but not when working with specific music technologies/computer software which often require quite different skills. Similarly, some pupils exhibit strong skills in relation to certain computer music programmes/ software, yet are not particularly interested or skilled in technologies generally; their proficiency often develops as a result of their involvement with that particular music technology at home. Without a clear awareness of the equipment/ software that pupils are using outside the classroom, and their competence with this, it is impossible for a classroom teacher to select the most appropriate technologies and pedagogical approaches for classroom work.

The other domain in figure 3 - (knowledge of) Pupils' Musical Preferences - has been identified as important in school music, particularly in relation to children aged 11-14 (Finney, 2007). At the turn of the century, in England, music was found to be one of the subjects most disliked on the school curriculum (Harland *et al*., 2000) and, a decade later, was still noted by many 11-14 year olds as one of their least favourite lessons (Jin *et al.,* 2010). This is a grave concern when music is such a vital part of almost every child's life, especially during the teenage years when it relates to the development of identity (Tarrant *et al*., 2002). In 2001, Sloboda noted: "Many school music educators have little respect or understanding for the musical lives of those they teach . . . the musical enthusiasms and aspirations of many young people are not addressed in the current curriculum" (p. 42); in my experience, Slodoba's comment still applies today. Research suggests that music technologies can excite pupils, in part, because they offer the young people opportunities to create music that relates to their own interest and lives outside of school (Gall & Breeze, 2008; Baxter, 2011). Given that the English National Curriculum (Gov.UK, 2013) does not prescribe content, approach or specific technological competences to be attained, I believe it vital that teacher educators encourage pre-service teachers to consider 'student voice', generally and, particularly, in relation to technology. This means engaging with the question 'What do pupils' want within and from their classroom music lessons?'. It is

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[14] I will not attempt to create a similar acronym, since it would be too complex.

recognised that novice teachers focus on their own teaching, as opposed to pupil learning, when they first begin work in the classroom (Gibbs & Coffey, 2004). However, consideration of pupils' interests, experience and aptitudes may well be key to engaging and motivating teenagers and, thus, to the creation of a positive classroom environment that is not only conducive to pre-service teachers' developing confidence generally, but also to their attitudes toward experimenting with technology in their teaching.

I turn now to a discussion of historical and philosophical roots of teaching and learning which Shulman (1987) suggested as part of the category Educational Ends, but which is omitted from the TPACK model. Within my graphic representation, as with Educational Contexts, the domain Educational Ends does not embrace all of the Music Technological Knowledge domain in order to account for staff such as 'music technicians', whose technology skills are strong but whose awareness of education may be limited. Regarding Educational Ends, a key aspect, relatively unmentioned in other discussions of TPACK, is that of culture. School music cannot be considered outside of its cultural context (Gall *et al.*, 2012). Thus, the types of music technologies deemed most appropriate for schools will vary from country to country depending on the focus within formal music education, which itself relates to the music that is valued within society. For example, whereas technologies for composing are commonplace within upper secondary school work in England, video and recording equipment are more significant within the Swedish music curriculum because of its emphasis on performing (*ibid.*).

Within my conceptual framework, I have made a change to Knowledge of Educational Ends, as presented by Shulman (1987), such that the area Personal Beliefs/Values is extracted and made distinct. This area is of great significance in initial teacher education: in relation to the values of staff in the institutions where student teachers carry out their school practice, and of the novice teachers themselves. Owing to the breadth and flexibility provided by the Music National Curriculum, a head of music's personal preferences can shape the whole music curriculum. Those who have strong beliefs that ICT threatens the norms and traditions of their subject are able to limit its use by pupils; conversely, teachers aware of the potential positive affordances of technologies for music learning and teaching can place a strong focus on ICT within the curriculum and are also are in a position to enable pupil choice - of content, technological tool, preferred approach to learning, etc. - when planning. In this context, trainee teachers may have very varied experiences during their school practice. In the best circumstances, a student teacher confident in the use of technology, through their own novel practices, can positively impact upon experienced staff's technical content, and pedagogical knowledge and also their attitudes. A more complex situation arises when a trainee is passionate about the importance of technologies for musical learning but has limited opportunities to trial their ideas in the classroom, because of the negative attitudes of the head of department. As the person responsible for organising the music teaching practice placements, I see the department's ethos in relation to music technology as a key consideration when selecting schools appropriate to each individual novice teacher.

The personal beliefs /values of the pre-service teachers themselves is highly significant to work as an initial teacher educator. My previous research has indicated that many music trainees begin the PGCE course with limited or no personal

experience of using music technology (Gall, 2013). Since personal histories shape novice teachers' attitudes to education and their professional learning (Olsen, 2008), it is vital that such student teachers are immersed quickly into activities in which they develop their own competence and confidence in the use of music technologies, to ensure that they are sufficiently skilled to begin trialling the integration of ICT into their classroom practice. This is particularly, important in the English teacher education context when there are only 10 months within which to influence student teachers' notions of their developing professional selves. Pleasingly, over the years, I have seen the placing of trainees who, initially, lack confidence and/or competence in using ICT, with school mentors who are skilled in this area lead to very positive attitudinal changes.

Music Trainee Teachers' Perceptions of Their Own Development in Relation to TPACK
As mentioned previously, there is insufficient space in this chapter to present the detail of the research that I am carrying out in relation to this conceptual framework. However, I now provide a short explanation of approaches within the first year of the study, and present a few of the points raised by the participants which particularly pertain to TPASCK and initial teacher education. A full discussion of the study is available in the forthcoming article: TPACK and More: Technological Pedagogical Content Knowledge in Secondary Music Initial Teacher Education (in process).

Trainee teachers engaged in the University of Bristol's PGCE Music course regularly reflect on their work, individually and within whole cohort discussions. In the academic year (2013/2014) the framework discussed above, was introduced into university sessions for the first time. All 12 of the novice teachers on the course were happy to be involved in this formal study. Data was collected from individual questionnaires, small-group dialogue, and a whole-cohort discussion on work with technology across the course; all discussions were recorded and transcribed. The participants were encouraged to reflect upon their work in relation to the framework, but there were no closed questions pertaining to it.

A key issue for all trainees who had come to the course with limited or no competence in sequencing and recording was the time needed to develop their own music technological knowledge. They were pleased that specific workshops were offered at the very start of the course to maximise the time for skills development, prior to work in schools. Five of those who were, initially, less confident/competent with music ICT noted that they had to spend a considerable amount of time on this in the early stages of the course. One felt that the only way he could feel confident of becoming skilled enough to lead ICT work in schools was to purchase the software for use on his personal computer, thereby giving him more opportunities for practise. Another explained she was pleased that the formally assessed ICT work featured within later school practices: "If this had been a requirement earlier in the year I'm not sure how I would have coped, as working things out for yourself takes quite a lot of time, which I definitely didn't have then." Another female, who had struggled with other aspects of classroom practice, towards the end of the course said that she did not feel she had become as competent as she had hoped, either in her own use of sequencing and recording software or in teaching with technology, because her priority had to be the development of general and musical pedagogical competence.

As might be expected, many of the student teachers raised issues related to the pedagogy surrounding the inclusion of technology into their lessons. As regards general pedagogical knowledge, two remarked on their initial management difficulties, one stating "I found it much harder when they were all seated around computers to manage behaviour". The other explained the importance of developing clear routines, just as one would in lessons that did not include technology, particularly in relation to saving work. A commonly raised problem, experienced during the practical sessions, was how to respond to the many questions pupils raised about operating the software; prior to planning and teaching a unit of work including technology (their first school-based music assignment), the majority were not aware of the detail that was required within support materials. One student teacher with strong personal music technology skills commented "I've realised it's important to have really, really good tutorial guides" and explained how he had created a series of 10 screenshot videos in which he modelled and explained what was expected musically, at the same time as demonstrating the functions of the software; these were uploaded on the pupils' shared drive for easy access.

In small group discussions, at the end of the course, many of the novice teachers recognised that they were drawing heavily on general/music pedagogical practices within the units of work that included ICT. One female stated: "It's an essential thing – modelling the work you expect from them (the pupils); now you just use it in relation to technology". Another remarked: "I think keeping the performance and audience aspects, even though the kids are on the computers, is important…and getting the students to evaluate each other's work".

Another point discussed in some length by the majority of the trainee teachers pertained to knowledge of the pupils, the positive affordances of the technology and pedagogy (TPACK). All the student teachers - even those practising in schools where ICT was a common feature in music lessons - noted that composition projects including technology required more time because pupils were having to develop skills in using the software. The trainee teachers were clear about the value of using computer music templates to scaffold learning when pupils were using music sequencing software, particularly noting their significance to lower-attaining pupils, but raised the question of how to structure learning to provide support yet still offer 'openness'. As one female commented, in relation to composition activities: "It's about getting a balance between helping them to produce something that sounds good to them but not limiting their creativity".

Further Thoughts
Designing this conceptual framework has helped to advance my thinking about the complexities of music teaching including technology, and is continuing to inform modifications to the UoB PGCE music course. It has also proven a useful focus for trainee music teachers in their reflections on their school and university-based work related to ICT.

I have already noted that any conceptualisation of educational practice is, essentially, specific to one country. Concerns about 'educational transfer' from one context to another are highly relevant to music education, owing to the diversity of cultural settings in which school music and teacher education take place (Hennessy *et al*., 2013). However, at an international level, there is a strong desire amongst music

educators for shared explorations of practice regarding technologies and musical learning within classrooms (Gall *et al*., 2012). Whilst, the model that I have presented in this chapter is located within an English context, it could form a starting point for further dialogue between teacher educators, within and across countries, about ways of supporting trainee teachers' development of the skills, qualities, pedagogies and understandings that are necessary for effective learning and teaching with music technologies.

References
Baran, E., Chuan, H-H. & Thompson, A. (2011). TPACK: An Emerging Research and Development Tool for Teacher Educators, *The Turkish Online Journal of Educational Technology*, 10(4), 370-377.

Baxter, A. (2013). Playstation Power: Removing Performance Barriers to Musical Composition. In J. Finney & F. Laurence (Eds.), *MasterClass in Music Education: Transforming Teaching and Learning* (pp.173-180). London/New York: Bloomsbury.

Bauer, W. (2010a). Technological Pedagogical and Content Knowledge for Music Teachers. In D. Gibson & B. Dodge (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2010* (pp.3977-3980). Chesapeake, VA: AACE.

Bauer, W. I. (2010b). Technological, pedagogical, and content knowledge, music, and assessment. In T. S. Brophy (Ed.), *The practice of assessment in music education: Frameworks, models, and designs* (pp. 425-434). Chicago, IL: GIA Publications.

Bauer, W. (2012). The Acquisition of Musical Technological Pedagogical and Content Knowledge, *Journal of Music Teacher Education*, 22(2), 51-64.

Bauer, W. (2014). *Musical Learning Today: Digital Pedagogy for Creating, Performing, and Responding to Music.* New York: Oxford University Press.

Bennett, S., Maton, K. & Kervin, L. (2008). The 'digital natives' debate: A critical review of evidence, *British Journal of Educational Technology*, 39(5), 775-786.

Chai, C-S., Koh, J. H-L., & Tsai, C-C. (2013). A Review of Technological Pedagogical Content Knowledge, *Educational Technology & Society*, 16(2), 31-51.

Clark, N. (2014). BA in beatboxing? Top conservatoire offers 'groundbreaking' performing arts degree, *The Independent*, 17 September 2014. Retrieved 26 June 2015 from http://www.independent.co.uk/student/news/ba-in-beatboxing-top-conservatoire-offers-groundbreaking-performing-arts-degree-9736587.html

Cochran, K.F., King, R.A. & DeRuiter, J.A. (1993). Pedagogical content knowledge: An integrative model for teacher preparation, *Journal of Teacher Education*, 44(4), 263-272.

Crow, B. (2008). Changing conceptions of educational creativity: a study of

student teachers' experience of musical creativity, *Music Education Research*, 10(3), 373-388.

De Baets, T. & Buchborn, T. (Eds.) (2014). *European Perspectives on Music Education (3) The Reflective Music Teacher.* Innsbruck: Helbling.

Department for Education and Employment (DfEE) /Qualifications and Curriculum Authority (QCA) (1999). *Music: The National Curriculum for England*. London: HMSO.

Department of Education and Science (DES) (1991). *National Curriculum: Music Working Group Interim Report*. London: DES.

Desmond, P. (2002). ICT in the secondary Music curriculum. In G. Spruce (Ed.), *Aspects of Teaching Secondary Music: Perspectives on Practice* (pp.155-172). London: RoutledgeFalmer.

Doering, A., Veletsianos, G. & Miller, C.S.C. (2009). Using the Technological and Pedagogical Content Knowledge Framework to Design Online Learning Environments and Professional Development, *Journal of Educational Computing Research*, 41(3), 319-346.

Evans, K. (2012). Music 14-19: Choices, challenges, and opportunities. In C. Philpott & G. Spruce (Eds.), *Debates in Music Teaching* (pp.197-208). Abingdon/New York: Routledge.

Finney, J. (2007). Music Education as Identity Project in a World of Electronic Desires. In J. Finney & P. Burnard (Eds.), *Music Education with Digital Technology* (pp.9-20). London/ New York: Continuum.

Gall, M. (2013). Trainee teachers' perceptions: Factors that constrain the use of music technology in teaching placements, *Journal of Music, Technology & Education,* 6(1), 5-27.

Gall, M. & Breeze, N. (2007). The subculture of music and ICT in the classroom, *Technology, Pedagogy & Education*, 16(1), 41-56.

Gall, M. & Breeze, N. (2008). Music and eJay: An opportunity for creative collaborations in the classroom, *International Journal of Educational Research, Special Issue - Music Education: A site for collaborative creativity*, 47(1), 27-40.

Gall, M. & Breeze, N. (2014). Initial Teacher Education in England: Music Trainee Teachers' Development of Technology Skills. In E. Himonides & A. King (Eds.), *Researching Music, Education, Technology: Critical Insights (Proceedings of the Sempre MET2014)* (pp.85-88). London: Institute of Education.

Gall, M., Lazarus, E., Tidmarsh, C. & Breeze, N. (2009). Creative designs for learning. In R. Sutherland, P. John & S. Robertson (Eds.), *Improving Classroom Learning with ICT* (pp.88-114). London: Routledge.

Gall, M., Sammer, G. & de Vugt, A. (Eds.) (2012). *European Perspectives on Music Education: New Media in the Classroom.* Innsbruck: Helbling.

Gibbs, G. & Coffey, A. (2004). The Impact Of Training Of University Teachers on their Teaching Skills, their Approach to Teaching and the Approach to Learning of their Students, *Active Learning in Higher Education*, 5(1), 87-100.

Gov.UK (2011). *Guidance: Teachers' Standards*. Retrieved 26 June 2015 from https://www.gov.uk/government/publications/teachers-standards

Gov.UK (2013). *National curriculum in England: music programmes of study*. Retrieved 26 June 2015 from https://www.gov.uk/government/publications/national-curriculum-in-england-music-programmes-of- study

Greher, G. (2015, in press). Technology in Music Teacher Education and the Enigma of Invisibility. In A. Ruthmann & R. Mantie (Eds.), *The Oxford Handbook of Technology and Music Education*. Oxford: Oxford University Press.

Harland, J., Kinder, K., Lord, P., Stott, A.Shagen, I., with Cusworth, L. White, R. & Paola, R. (2000). *Arts Education in Secondary Schools: Effects and Effectiveness.* Slough: National Foundation for Educational Research.

Hennessy, S., Malmberg, I., Niermann, F & de Vugt, A. (2013). MeNet and Learning Outcomes: Music Teacher Training for Specialists and Generalists. In A. de Vugt & I. Malmberg (Eds.), *European Perspectives on Music Education (2) Artistry* (pp.259-281). Innsbruck: Helbling.

Jin, W., Muriel, A. & Sibieta, L. (2010). *Subject and course choices at ages 14 and 16 amongst young people in England: insights from behavioural economics*. London: Department for Education.

Just, S. & Pyrek, D. (2013). TPACK in the Elementary Music Classroom. Retrieved 26 Jun 2015 from http://www.macul.org/downloads/2013_macul_conference/macul_2013_program_book_2_20_2013_20130226_080243_1.pdf

Kwami, R.M. (2001). Music education in a new millennium. In A. Loveless and V. Ellis (Eds.), *ICT, Pedagogy and Curriulum: Subject to Change* (pp.216-228). London/ Abingdon/ New York: RoutledgeFalmer.

Lamont, A. (2002). Musical identities and the school environment. In R.A.R. MacDonald, D.J. Hargreaves & D.E. Meill (Eds.), *Musical Identities* (pp.41-59). Oxford: Oxford University Press.

Loughran, J., Mulhall, P. & Berry, A. (2008). Exploring Pedagogical Content Knowledge in Science Teacher Education, *International Journal of Science Education*, 30(10), 1301-1320.

Mishra, P. & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A framework for teacher knowledge, *Teachers College Record*. 108(6), 1017-1054.

National College for Teaching and Leadership (NCTL) (2015). *Initial teacher training (ITT) criteria supporting advice*. Retrieved 26 June 2015 from https://www.gov.uk/government/publications/initial-teacher-training-criteria-supporting-advice

Office for Standards in Education (Ofsted) (2009). *Making More of Music: an evaluation of music in schools 2005-08*. (HMI 080235) London: Ofsted.

Office for Standards in Education (Ofsted) (2012). *Music in Schools: wider still, and wider.* Retrieved 26 June 2015 from http://www.ofsted.gov.uk/resources/music-schools-wider-still-and-wider

Olsen, B. (2008). *Teaching What They Learn, Learning what They Live: How Teacher Personal Histories Shape Their Professional Development*. Boulder, CO: Paradigm Publishers.

Philpott, C, & Carden-Price, C. (2001). In C. Philpott (Ed.), *Learning to Teach Music in the Secondary School*: *A Companion to School Experience* (pp.177-200). London/NewYork: RoutledgeFalmer.

Pierson, M. E. (2001). Technology integration practice as a function of pedagogical expertise, *Journal of Research on Computing in Education*, 33(4), 413-430.

Prenksy, M. (2001). Digital Natives, Digital Immigrants. *On the Horizon*, 9(5), 1-6.

Selwyn, N. (1999). Differences in educational computer use: the influence of subject cultures, *The Curriculum Journal*, 12(1), 11-29.

Shulman, L. S. (1987). Knowledge and teaching: foundations of the new reform, *Harvard Educational Review*, 57(1), 1–22.

Sloboda, J. (2001) Emotion, Functionality and the Everyday Experience of Music: Where does music education fit?, *Music Education Research*, 3(2), 243-253.

Sullivan, L., Dunn, M., Thorne, G. & Zenbergs, L. (2009). *Prodigy project: supporting music technology pedagogy in schools and further education institutions.* Retrieved 26 June 2015 from https://www.heacademy.ac.uk/resources/detail/LLN/YHELLN_Supporting_music_technology

Tarrant, M., North, A., & Hargreaves, D. (2002). Youth Identity and Music. In R. Macdonald, D. Hargreaves, & D. Miell (Eds.), *Musical Identities* (pp.134-150). Oxford: OUP.

Teacher Training Agency (TTA) (2002). *National Curriculum for the Using Information and Communications Technology to meet teaching objectives in music initial teacher training: secondary (publication 40/5-99)*. London: TTA.

Thompson, A. D. (2008). Breaking news: TPCK becomes TPACK! *Journal of Computing in Teacher Education*, 24(2), p.38.