Supporting teachers' development of Technological Pedagogical Content Knowledge: a whole school intervention

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A Research & Development Project Submitted for the MSc in Learning & Teaching 2019

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Supporting teachers' development of Technological Pedagogical Content Knowledge: a whole-school intervention

Abstract

There is a general consensus that teachers and schools need to use technology in the classroom to support their teaching practice and increase students' engagement, and this drives schools to spend an appreciable part of their available budget on technological tools. Furthermore, empirical research suggests that educational technology (such as Virtual Learning Environments (VLEs)) and the use of blended learning improve students' outcomes in different subjects. Other studies, too, indicate that increasing teachers' mastery and use of educational technology may also help to enhance students' engagement. However, teachers vary widely in their competence in applying and managing these technologies, with some scholars positing that issues such as cost, teachers' beliefs and a lack of appropriate training of teachers seriously undermine the benefits and value added of using digital technologies.

With a view to addressing these shortcomings, this small practitioner study explores a whole-school intervention to support teachers' better use of educational technology(i.e. the VLE). This intervention was conducted in three stages combining department-based and whole-school sessions. Each session was designed as a task on the platform and was delivered with the collaboration of three colleagues from different departments. With this in mind, a framework was designed based on Technological Pedagogical Content Knowledge (TPACK) and the so-called Conversational Framework (CF) which helps to refine this. The research data was gathered in three ways. *Firstly,* individual interviews were conducted with teachers and group interviews with students. *Secondly*, both teachers and students answered online questionnaires enquiring into teachers' technological knowledge. And *thirdly*,

in conversations with staff members, their relevant experiences were recorded in a researcher diary.

The resulting findings suggest that, despite certain barriers to the adoption of digital technology, students perceived that teachers had made progress in their use of the VLE. Additionally, teachers valued the department-based approach, and the framework (combining TPACK and CF) appears to be a useful tool for developing teachers' expertise in the use of educational technology, whilst challenging some teachers' beliefs. However, there were some limitations in the area of students' engagement, and further research is required to determine the impact on students' outcomes.

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1. Introduction

As a *Website and Virtual Learning Environment (VLE) Coordinator at* a North Oxfordshire secondary school, I am aware of the challenges that teachers face when using VLEs, and I have to plan ahead in order to support them. In this study, I document the process of implementing a department-based approach to Continuing Personal Development (CPD), identifying the areas of success, limitations and opportunities of such implementation.

Research suggests that schools currently spend considerable sums on ICT. However, some posit that a lack of training (Koelher & Mishra, 2009; Koehler, et al., 2017), the way teachers relate to digital technology, and how educators' perspectives change (Voogt, et al., 2012) may either facilitate or compound the implementation of the VLE. Thus, CPD may be more beneficial than simply targeting students' use of the VLE.

This topic is important for my current school because it has invested in a VLE to help students access content outside school, thereby broadening the resources available to them. Whilst the focus thus far has been on the administrative benefits of the VLE, sharing files with students, setting homework and, occasionally, contacting teachers or students, there remains scope for developing its educational and pedagogical potential. Increased engagement and more active participation on the part of teachers using this resource would, hopefully, mean better value for money for the school as a whole.

However, the use of such technology in secondary schools still appears to be largely undocumented in comparison with higher education (HE) institutions, and thus there is ample scope for research in this area. Furthermore, since VLEs were first developed for, and implemented within, universities, their introduction into schools is a direct consequence of their success in HE. However, questions remain regarding their use and potential for success within secondary education, as well as about the attitudes of teachers towards this type of technology and the way it affects pupils' engagement.

Finally, at a more personal level, this topic is particularly relevant to me in my capacity as Website and VLE Coordinator, since my ultimate aim is to integrate technology and pedagogy in a way which helps teachers to reduce their workload, while increasing opportunities for students and facilitating their access to knowledge.

2. Literature Review

This literature review is arranged in four sections. *Firstly,* contextualisation of the research will aim to provide a definition of VLE appropriate to this study. We will then focus on the historical background, including efforts made to implement digital technology in the UK schools system, the circumstances in which the introduction of VLEs has taken place, and the ways in which technology may trigger new developments in education, possibly resulting in time in a new pedagogical context with different perspectives. *Secondly,* I will outline the challenges that teachers may face when using technology, including the issue of self-positioning (somewhat embedded in the argument over the digital divide), and how teachers' beliefs affect their relationship with technology. *Thirdly*, some of the opportunities offered by the use of blended learning will be discussed. *Fourthly*, I will analyse empirical studies on how the VLE works in different subjects, opening the way to the creation of a framework designed to satisfy the needs of the present study.

2.1. Contextualising VLEs in education

2.1.1. Towards a definition of VLE

In the interests of transparency and informing the historical background, I feel it necessary to provide a definition of the VLE which, notwithstanding its long use, remains subject to debate, with an array of classifications being available (Becta, 2003a). This present study will only look at two definitions, which match the functionalities offered by the VLE in use at the school where the current research has

taken place. On the one hand, a VLE is considered "a collection of software tools supporting academic administration, teaching and research using the Internet, particularly the World Wide Web" (Trafford & Shirota, 2011, p. 143). On the other hand, it may also be understood as "a software tool which brings together in an integrated environment, a range of resources that enable learners and staff to interact online and includes content delivery and tracking" (Becta, 2003b). The reason for the choice of these two is that the VLE used at my current school (mylearning.com) offers both of these sets of features, with basically 5 areas of functionality forming part of most VLEs: 1) *information* (distribution of news, data and other documents); 2) *content* (allows access to multiple sources such as lecture notes, videos, and other electronic resources); 3) *communication* (tools such as email, forums etc); 4) *assessment* (surveys and assessments, both formative and summative) and 5) *management* (planning and delivery of courses, task setting, administration of marks etc.) (Trafford & Shirota, 2011; Becta, 2003a).

2.1.2. Historical background

Technology is no newcomer to the field of education and as traditional forms (e.g. pencils, books etc.) have become more commonly used and 'transparent', they are no longer considered technologies (Koelher & Mishra, 2009; Koehler, et al., 2017). However, owing to their versatility and rapidly changing nature, the technologies with which this project is concerned, digital technologies, pose problems when introduced into an already complex educational context and are therefore less likely to become established (Koelher & Mishra, 2009; Koehler, et al., 2017).

Furthermore, some scholars maintain that all technologies have their 'affordances', making them non-neutral and not unbiased (Koelher & Mishra, 2009; Cox & Webb, 2004), and this, combined with social and contextual factors such as lack of training, and self-positioning (Koelher & Mishra, 2009; Koehler, et al., 2017), may further complicate the implementation of digital technology, where one tool may be used as a whole-school approach.

The way in which those social and contextual factors manifest in history, and how they affect the use of ICT, make it necessary to explore how the drift towards digital technology in UK educational contexts has occurred. Some academics state that the 'push' for technology started with politicians such as Kenneth Baker promising in 1980 to provide a computer for every school, and it continued from 1997 onwards under the New Labour administration (John & Wheeler, 2008). John and Wheeler (2008) describe two key waves for the introduction of technology as an educational tool in schools, both occurring during the government of Tony Blair:

The first wave was based on the document *Connecting the Learning Society* (DfES, 1997)*, and saw* unprecedented levels of investment in hardware in schools. However, this initiative generated doubts in the minds of headteachers, who did not appear to challenge its effectiveness, even though there was a lack of learning-related training (Arthur, 2010). *The second wave* was based on the 'e-Strategy': Harnessing Technology – Transforming Learning and Children's Services (DfES, 2005). This was also supported by heavy investment in hardware and in training, plus integration into the curriculum. However, progress was deemed slow and inconsistent (John & Wheeler, 2008). Despite this, the drive for the use of technology did not diminish. In 2015 the *ICT*

Services for Education agreement was reached, and it will run for 4 years expiring in 2019 (Crown Commercial Service, 2015).

During these two waves VLEs were brought into the classroom (in the late 1990s) using non-web-based platforms (Becta, 2003a). They became more established in HE than in schools. However, further education institutions received funding from the National Learning Network for the implementation and development of VLEs (Becta, 2003a). By 2003, when Becta (2003a) (British Educational and Communicational Technology Agency) published their report on the literature on VLEs, the use and implementation of this technology was said to be immature and highly changeable. However, although Becta suggested that in 2003 the United States and Australia were already using these platforms in many of their high schools, Becta (2003a) also pointed to research showing that these countries were in the early stages of development. Even with these warnings, though, these systems started becoming increasingly popular.

2.1.3. A new context for education

It could be argued that using technology in education differs from that in the wider field of ICT. Indeed, the divide between educational and everyday contexts had already been suggested by Vygotsky (1978), who proposed that one key difference is that educational content is deliberately selected and arranged to suit educational and teaching purposes, making it distinctive from everyday information, which is not categorised with a particular purpose in mind (Bennet & Matont, 2010). Examining this notion of Vygotsky, Bennet & Matont (2010) argue that to use everyday situations to

evaluate changes in formal educational contexts is to misunderstand and undermine educational practices. Consequently, these two contexts must be treated differently, without giving prevalence to one over the other. These ideas are echoed and updated by a study conducted in the UK with secondary school students, in which it is argued that the 'alignment' of the educational and recreational contexts needs to be reconsidered (Crook, 2012). Crook (2012) researched four communicative themes (inquiry, collaboration, publication and literacy), and in his findings he argued that, concerning these themes, the use of communicational technology at school is fundamentally different from that in the wider, out-of-school environment.

However, technology is not neutral and a failure to recognise the effects that this everyday tool may bring into education could constitute a risk that needs consideration when drawing any contextual distinctions. Already, the introduction of new technologies in education has led to the '*content-dialogue*' debate. Here, '*content*' is usually the preferred option of e-learning detractors, whose concept of education is *instructivist* (i.e., based mainly on the learning of facts); '*dialogue*', on the other hand, is valued by those who are considered *enthusiasts,* and whose pedagogical ideas move in the field of constructivism (the pedagogical model to be used with technological or digital classrooms is believed to be a collaborative one (John & Wheeler, 2008)) where dialogue takes a central role (Weller, 2007). Platforms such as VLEs seem to make this argument more complex, bringing further divisions within the population of enthusiastic 'tech savvy' teachers, two main groups being recognised: the *revolutionaries* (*those* who encourage new technological developments and value flexibility) and the *democrats* (those who value the robustness of the systems and their practicality) (Weller, 2007; John & Wheeler, 2008).

This could clearly pose some challenges for teachers, although not necessarily in a negative way. Some researchers argue that new technologies would influence teaching on three different fronts: *firstly*, challenging skills development, *secondly* changing teachers' roles, and *thirdly*, challenging and changing the pedagogies employed, thus generating some divisions (Broadley & Trinidad, 2008).

2.2. The main challenges that teachers face regarding technology

Many teachers may, for different reasons, describe their interaction with digital technology as a love-hate relationship, sometimes including some reference to the generational divide. Despite this, scholars such as Bates (2005) and Broadley & Trinidad (2008) view e-learning as a valuable tool, which facilitates personalised learning, eases the access to information and communication and lends flexibility to education. But the success of its implementation, they argue, depends largely on engaging learners and using the appropriate pedagogy, on utilising the full potential of technological platforms, and on learning and student-centred emphases (Broadley & Trinidad, 2008). However, Weller (2007) argues that some HE institutions acquired VLEs without having a clear idea of what they aimed to achieve with them. This is a pattern that may have been replicated in secondary schools (Broadley & Trinidad, 2008). This problem could have resulted in an unbeneficial and basic use of VLEs.

2.2.1. Challenges in the school context

Conversely, some scholars argue that teachers are central to the development of such technologies, and without their commitment to the use and implementation of technology in the classroom, this enterprise would fail (John & Wheeler, 2008; Weller, 2007), so that their training and commitment could be indispensable for the effective use of e-learning. However, there is little reference in the academic literature on ways to train teachers on the use of e-learning involving the VLE. Broadley & Trinidad (2008) and Becta (2004) remark that failure to prepare and help teachers may also lead to their becoming a barrier to the implementation of e-learning technologies. Consequently, both researchers and government institutions warn about the challenges faced when persuading teachers that using digital technology is worth the effort. These challenges include, f*irstly*, the perception that the technology involved in the VLE is costly and mastering its use is a time-consuming process, introducing additional challenges into an already busy profession. Therefore, the lack of time for practising may become somewhat problematic. *Secondly*, lack of confidence, lack of competence (the absence of, or inadequate familiarity with, the software and hardware), lack of resources and lack of a supportive culture may foster further resistance to change, as teachers may feel less poised than students, and thus undermined, when managing technology. This could, in time, lead to misunderstandings about the benefits offered by using technology in the classroom. *Thirdly,* teachers may perceive that there is a lack of senior management or technological support. This feeling is present when the aids provided are simply based on technological tips, rather than connecting with the pedagogy and the teaching style of the teacher and may therefore generate the impression among teachers that the acquisition of ICT skills does not fall within their remit (John & Wheeler, 2008; Lyndon

& Hale, 2014; O'Mahony, 2003; Becta, 2004; Nikolopoulou & Gialamas, 2016; Thorsteinsson, 2013).

The above challenges could mean that topics such as VLEs and e-learning inspire more resistance than enthusiasm among some teachers (Weller, 2007), as they imply acquiring additional pedagogical skills to the detriment of time (including personal time(2004)). However, some researchers argue that time consumption is highly dependent on how the learning environment is used. For instance, creating multiple-choice tests is more time-consuming than writing comments for online forums (Lyndon & Hale, 2014). Another problem highlighted in the literature is that it is not simply teachers who may have issues with the use of the VLE. Students, even those who have the requisite skills, may not work on the VLE owing to technical problems, to materials online that only replicate offline tasks, or to a lack of relevance of the information (Lyndon & Hale, 2014). Furthermore, the inclusion of too much information may also become overwhelming (Jelf & Kelly, 2007).

This makes the overall success of VLEs dependent on the technical abilities of both the teacher and the student (Lyndon & Hale, 2014). Accordingly, training teachers is highly beneficial (Becta, 2004). However, training that does not target specific subjects tends to be highly criticised by teachers for not appearing relevant to their practice (Goodwyn & Findlay, 2003). Furthermore, in their 2006 report, Becta (2006) pointed to the continuing need for further development of skills and of teachers' confidence in the use of ICT. The focus on engagement is highly valuable because, in order for the VLE to be successful, teacher-student participation is essential, maintaining both channels of communication and up-to-date files (Lyndon

& Hale, 2014). When this is accomplished, test scores for students tend to show higher marks (Leese, 2009). Furthermore, scholarly research such as that of Lyndon & Hale (2014) appears to confirm how using VLEs as tools for communication and collaboration at university is highly beneficial for learners, and that the benefits of their use outweigh the challenges.

2.2.2. Self-positioning and the generational divide

It may be argued that the limited resources available to teachers for deepening and increasing their knowledge and productivity in their specific areas affect their interaction with digital technology (Weller, 2007). Additionally, previously expressed academic views may have impacted teachers' perceptions of the use of technologies. An example of this may be found in the suggestion that the mastery of digital technologies is dependent on a generational divide (Prensky, 2001a; 2001b), with Prensky classifying technology users as *digital natives* or *digital immigrants,* purely on the basis of their date of birth (John & Wheeler, 2008; Underwood, 2007)). Ideas such as this may influence the way in which teachers self-position when working with digital technologies.

Helsper & Eynon (2009), however, opposing the views of Prensky (2001a; 2001b), argue that the age-based category of digital natives fails accurately to embrace those who have sound technological knowledge. Rather, they suggest that experience (longest use of, and greatest level of immersion in, the internet) and breadth of use (the number of different things done on the internet) are the criteria that should be applied to

assess the sophistication of the use of technology. In their study they discovered that, although younger generations tended to use technology more, age was not the only variable intervening in the formation of technologically savvy users (Helsper & Eynon, 2009). They also concluded that, even though learners needed to be understood in order to be taught well, using age as the sole criterion for classification may encourage deterministic views which are not based on evidence (Helsper & Eynon, 2009). Their findings are supported by Bennet et al.(2008), who challenged the two core claims made by Prenksy (i.e. that young people have higher levels of use and command of digital and technological skills and that *digital natives* have distinctive learning preferences). *Firstly,* Bennet et al.(2008) maintain that although younger people are certainly more adept at using technology, their level of technical use and knowledge of ICT is not sufficiently deep to allow them to be identified as *digital natives* (i.e. they are not capable of producing their own content and multimedia for the web).

There are other studies such as those by Bennet & Matont (2010) and Margaryan et al.(2011) which share similar views regarding the notion of the digital natives generation, the latter concerning university-level users. Furthermore, evidence shows that there is no homogeneous use of technology in the generations born after 1983 who are entering university, which clearly calls into question the notion of a digital native or 'net generation' (Jones, et al., 2010; Kennedy, et al., 2008). This is also supported by Foote's (2008) study, according to which one third of teachers over the age of 40 who took part in her research were competent with the use of computers, demonstrating once again that, despite the instantly appealing notion of a generational divide, the distinction is not that clearly delineated.

Incidentally, John and Wheeler (2008) (based on Wheeler and Winter (2005)) argue that the most difficult challenges lie within the psychological domain, rather than the age gap. Such challenges may be associated with preconceived *beliefs* prevalent in different cultures and may affect the mindset of teachers and pupils (Bruner, 1999). This claim appears to support the arguments posited by Becta (2004). John & Wheeler (2008) also highlight how resistance to the use of technology may be the result of adverse prior experiences, and this could be true for both younger individuals and more mature adults.

2.2.3. *Teachers' beliefs*

In general, teachers' experiences and the apparent lack of resilience (e.g. Grey (2001) argued that teachers tended to give up rather than try to understand how computers may malfunction) may affect teachers' 'self-efficacy', i.e. the wider psychological notion that the belief "in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). Such self-efficacy is not a skill per se; "it rather reflects what individuals believe they can do with the skills they possess" (Underwood, 2007, p. 215). Using digital technology requires both self-belief and digital literacy, the latter being particularly likely to empower teachers (Broadley & Trinidad, 2008), but both play a key role. Furthermore, Voogt et al. (2012), based on Cox & Webb (2004), claim that the pedagogical and technological *beliefs* held by teachers also influence how teachers interact with technology and incorporate it in their subject-areas, a view that is shared by other researchers (Nikolopoulou & Gialamas, 2016; Jimoyiannis & Komis, 2007). Some of

them argue that 'subject-areas' may also influence such beliefs and the way digital technology is integrated into school (Howard, et al., 2015). Thus, they appear to acknowledge that teachers' Pedagogical and Technological Knowledge may help them to overcome such beliefs and their influence. And this in turn would possibly mean that teachers have a clearer understanding of the reasons why digital technology is used in their lessons.

2.3. Opportunities and challenges of using blended learning

Blended learning developed because, despite the introduction of educational digital technology (particularly in universities), conventional communication remained relevant (Teng, et al., 2009; Margayan, et al., 2004), and new approaches combining both traditional and technological new ways of accessing and developing learning were deemed necessary (Moe & Stale, 2011). Consequently 'blended environments' were proposed using classroom and online learning (Lyndon & Hale, 2014). Paulsen (2008) proposed *cooperative learning* as a way of harmonising individual and collaborative learning through online learning and applying the 'three pillars' of Cooperative Freedom, that is: it is voluntary, promotes flexibility, and occurs within a community. This facilitates flexibility and improves the quality of students' contributions and tracking of students' progress (Paulsen, 2008).

These proposals imply that face-to-face teacher-student interactions would not disappear, and that teachers' ideas and behaviours would still affect students' work and motivation, as they usually do in classroom context (Christophel, 1990).

Consequently, implementing digital technology is assumed to be based on the teacher-student contract (Mayes & Fowler, 1999). Thus, blended learning requires creating an ethos where there is mutual support (teacher-student), whilst the teacher assumes shifting roles as instructor and co-learner, aiding the creation of a community of learners and a collaborative environment (Broadley & Trinidad, 2008). For this, students should know their role and place on the VLE or its equivalent (Leese, 2009).

Other studies (e.g. Aspden & Helm (2004)) show that this approach to e-learning (in universities) has multiple benefits, and these findings reflect findings in schools (Becta, 2003b). They also claim that learning online allows students to coordinate their various activities more successfully because of the flexibility of the system, and increases their interaction with others (Aspden & Helm, 2004). Furthermore, meta-analyses by Cox & Webb (2004) show how blended learning is beneficial for students' learning by enabling teachers to target higher-order skills.

However, collaboration alone is not necessarily enough, since learning also requires reflection and praxis (Mundkur & Ellicson, 2012). Moreover, blended learning is said to involve a shift in mentality, and a new paradigm for student learning. This transforms students from receivers of content into thinkers and producers of knowledge, enabling them to build fundamental skills such as digital literacy, self-regulation, independence, collaboration and communication (Nolan, et al., 2012). Additionally, Ni (2013) recognises that students feel less intimidated interacting on VLEs, which increases the quantity and quality of such interaction, but she also warns that the advantages of online use and interaction may not be possible if there are not close connections between learners. This may mean that it is not only about cooperation,

but also about the depth of the relationships established in such a process, as teachers still play a central role in the process of learning even now with multimedia tools (Neo, et al., 2013). Thus, digital technology seems to have an increasingly fundamental role to play in education, such that some would argue that the advancements in ICT helped to overcome some of the barriers to the acquisition of knowledge and to the creation of new opportunities (Elinwa & Agboola, 2013), while at the same time creating a sense of community (Lyndon & Hale, 2014).

Some maintain that the benefits of this approach are not without contention and that the online resources also need to be evaluated with the aim of tackling problems such as workload (Jelf & Kelly, 2007). Furthermore, research on the effect of VLEs on students' learning appears to be limited and some of it seems to assume that both access to resources and engagement can be understood in the same way, as many studies count the amount of times a file is downloaded or a page is viewed as an indicator of the engagement of the audience with the resource (Lyndon & Hale, 2014). But this way of approaching and reading the information can be misleading, since accessing a file does not necessarily imply active student involvement (Lyndon & Hale, 2014). Furthermore, Lyndon and Hale (2014), based on Gonzalez (2010) and Blass & Davis (2003), claim that many teachers use the VLE purely as a means to deliver information, and this does not improve students' learning or engagement. In contrast, collaborative environments where debate and discussion are available are shown to be highly beneficial for students' learning (Lyndon & Hale, 2014). Ultimately this would appear to suggest that it is not only using blended learning that is important, but also the way it is used. In their research, scholars such as Hodges et al.(2018) employed other tools such as game-based environments in order to help students practise

chemistry skills in secondary schools. They found using blended learning beneficial and claimed that the progress made by students who adopted this method of learning was significantly higher. This seems to ratify the idea that the mode in which blended learning is used is critical for its success.

2.4. VLE in different subjects

Some studies conducted by researchers in multiple departments such as Hughes et al.(2007) found discrepancies between the literature on online learning and the results of their own research. Whilst the literature available claimed that online learning of Maths was not as effective as classroom-based learning, their research (conducted with three traditional and three virtual schools), showed that students who studied Maths online outperformed those who were classroom-based. These findings are supported by the research conducted by Ronnie (2011), who used the VLE to enhance the assessment for learning with SEN students in Maths in secondary schools in London, finding that the VLE helped students to learn faster and the feedback provided by the platform was greatly valued by students. Manuel and Freiman (2017) found similar results in their study with Gifted and Talented students.

This posits the question: Is the VLE effective in different departments? Empirical studies showed that critical differences in the way that subjects have incorporated ICT are particularly noticeable in secondary schools, with subjects such as ICT, Science and Maths (the latter in a more instructivist than a constructivist way (section 2.1.3)) exhibiting a greater use of technology, English offering limited

implementation (mainly using word processors), and a very low use of digital technologies in humanities (Cox & Webb, 2004). The research in other secondary school subjects is limited, and those studies that exist suggest a very low use of technology in subjects such as RE and PE (Cox & Webb, 2004). Overall, it is important to clarify that using ICT does not necessarily translate into improved learning. For digital technology to be effective, teachers need to know how to use it for their respective subject-areas and objectives (Cox & Webb, 2004). However, as discussed above, efficient use of ICT may modify the classroom interactions involved in learning, leading to improved independent work (Cox & Webb, 2004).

Furthermore, Kojy Takahashi et al.(2015) developed a study based on a science experiment conducted via a VLE and a virtual laboratory. In their findings they claim that, despite some problems of functionality regarding the VLE and the need for further research, the potential of technology is promising (Kojy Takahashi, et al., 2015). Likewise, in another project conducted by Ibañez et al.(2014) where Augmented Reality (AR) was used to teach electromagnetism, it was discovered that the VLE offers an effective platform for teaching the subject when a good balance of task difficulty and AR support is offered. Equally, in a study conducted by Xu et al.(2011) on the use of digital storytelling, the authors claim that online tools appear more effective than those offline, and that the former may help teaching writing in the classroom. They further maintain that digital storytelling adds flexibility, universality and interactivity, allowing students to use different formats (Xu, et al., 2011). Similarly, a separate study by Roulson and Clarke (2003) aimed at working collaboratively to resolve decision-making exercises in geography found use of the VLE as a technological platform for aiding their work beneficial. Similar claims are made by García-Gil & Cremades-

Andreu (2017) on the development of music using the VLE. However, there are some issues linked to the use of this digital technology. As Moss (2003) points out, the methods teachers use to evaluate and select software to support their subjects show that they do not fully understand the opportunities offered by digital technologies for encouraging independent learning. Even though teachers may believe in constructivist learning methods, they tend to choose software that does not work as a companion to constructivism. Furthermore, Ping Lim & Sing Chai (2008) suggest that teachers' beliefs compatible with constructivism are not enough to overturn traditionalist uses of technology. However, other studies imply that, although teachers use technology mainly for transferring knowledge, this is far from being the only way in which educators interact with and use ICT in the classroom (Heitink, et al., 2016). This would indicate that there is no single well-known method for integration of technology in the classroom; rather, there are various ways of effecting such integration, taking into account each subject-matter and context and employing a technology that is compatible with the teacher's pedagogical beliefs (Koelher & Mishra, 2009).

Overall, the literature suggests that starting with a contentious definition of the VLE, the implementation of ICT in UK secondary schools has been inconsistent. This is because, although there has been historical investment and a push for the introduction of technology in schools, such steps appear to have been made at great cost, with a general lack of training and little attention to evidence. It could then be argued that such inconsistency has further complicated the uptake of ICT-based tools such as VLEs. Furthermore, the lack of knowledge of the affordances offered by technology, teachers' beliefs and challenges posited by using ICT in the classroom, as well as the poor engagement of learners using tools such as the VLE, further

problematise the use of digital technologies. However, the opportunities presented by using blended learning hold out a promising prospect for the development of these techniques in the classroom. This is supported by empirical research conducted in multiple subject-areas. With this in mind, the understanding that teaching with digital technology requires a particular approach must be considered. To support the implementation a framework has been developed based on the ideas from De Freitas, TPACK and CF. This is explained in the following section.

3. Framework

It is believed that, if training is to be provided for the VLE using the platform itself, it is likely to benefit from a tailored approach to teaching with technology. Furthermore, its use may possibly be adopted by teachers if they find it suitable. It is argued that, while e-learning does not have its own educational theory, its use enhances, or fosters the development of, other models (Mayes & De Freitas, 2004). To achieve this end, Mayes and De Freitas (2004) argue, there must be consistency in pedagogical design between the curriculum (Content Knowledge), teaching methods (Pedagogical Knowledge), the environment (Contexts) and the assessments used.

On this, Mayes and De Freitas (2004) state that there are three different assumptions underpinning e-learning design and use, which are fundamental to our understanding of learning. *Firstly*, the *associationist/empirist* perspective, in which knowledge involves a systematic gathering of skills and associations to create sequences of activity which represent learning, the fundamental principle here being the formation, adaptation and amending of connections by using feedback(also understood as task analysis).

Secondly, the *cognitive perspective*, where besides thought, language and reasoning processes, learning is the result of the laying down of memory and the process of construction of concepts (also viewed as conceptual development through developing understanding and use of reflection). For this perspective, knowledge is understood as the interaction between structures of pre-existent or pre-created knowledge and new experiences. This perspective may be regarded as similar to Piaget & Inhelder's (1956) notions of personal constructivism, since it is based on problem solving and movement from concrete objects into more abstract ones. *Thirdly*, the *situative perspective*, in which students will always be subject to the influence of their socio-cultural environment. In this perspective, knowledge must be meaningful whether it is activity-based or group/relationship-based (it aids the development of collaborative learning and discourse using enquiry and dialogue) (Mayes & De Freitas, 2004). It might also be argued that three elements accompany the three perspectives, if the latter are conceived as a process where knowledge is structured as follows. Firstly, experimentation, problematisation and discovery are allowed take place to form a new 'theory' (conceptualisation). Then, an a*ccretion of* meaning occurs, adding new knowledge (testing/construction). *Finally*, the knowledge and skills are adapted *and developed* as a result of the new knowledge added to it (dialogue/reconceptualisation) (Mayes & Fowler, 1999).

Others consider that, to achieve the real potential of the blending of technology and classroom, student-centred approaches are necessary.(Nolan, et al., 2012). Some researchers such as Di Blas et al.(2014) maintain that ICT is currently refreshing teaching approaches and they advocate the use of strategies such as Technology, Pedagogy and Content Knowledge (TPACK), which places technology and

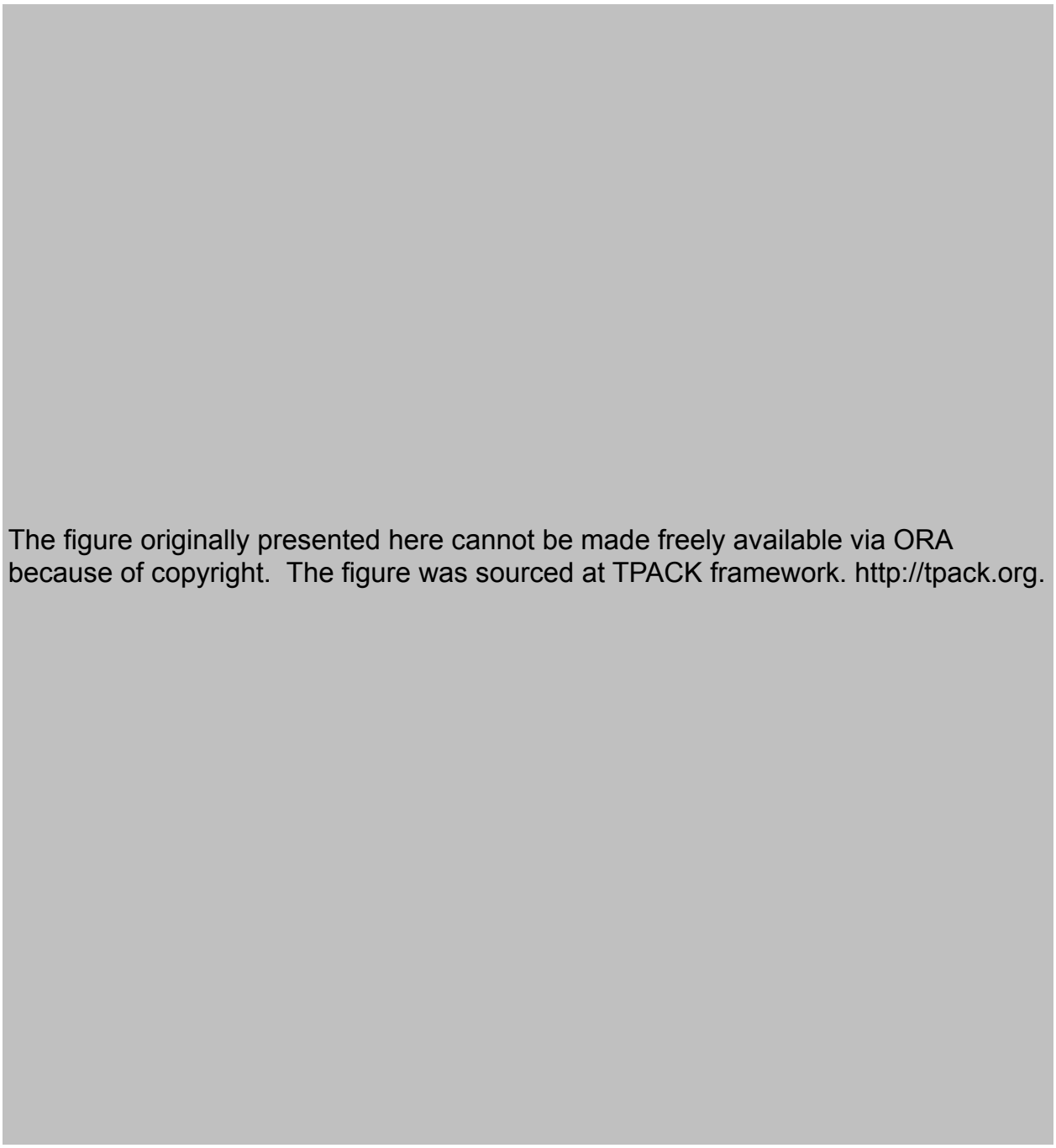
pedagogy at its core. This view is supported by scholars such as Elinwa & Agboola (2013), Roulston & Clarke (2003) and Mayes & Fowler (1999), among others, who argue that constructivist approaches based on Vygotsky are highly beneficial as an appropriate educational theory that would best utilise the potential of ICT. This is because, according to Vygotsky (1978), learning involves dynamic processes where learners move from a current level of intellectual development to their Zone of Proximal Development, in which they are able to solve new problems. He also argues that using verbal communication is fundamental for the execution of tasks or instructions. Learners, he says, contribute meaning when they communicate ideas. Thus, this approach implies a meaningful, active and interactive construction of knowledge (Elinwa & Agboola, 2013; Mundkur & Ellicson, 2012), in which teachers use verbal communication to convey ideas effectively whilst supporting students and facilitating the exchange of notions between teachers and students, as well as between students (Holmberg, 2016).

3.1. Technological Pedagogical and Content Knowledge

As suggested above, TPACK is one of the various possible options for the integration of technology in the classroom. It has been considered in this research because of its integration of contexts with multiple knowledges that are part of teaching practice. This approach embraces three different domains of knowledge: *Technological Knowledge* (the knowledge of working with technology, but also going beyond this simple concept. It involves the ability to judge when a technology is appropriate or when it would impede learning. It is very difficult to define, owing to the fact that it is ever evolving(Koelher & Mishra, 2009)); *Pedagogical Knowledge* (the various theories,

methods and practices about teaching and learning (Koelher & Mishra, 2009)) and *Content Knowledge* (concepts, theories, evidence, *inter alia*, as well as those techniques used for developing knowledge. Their use and depth vary according to the subject (Koelher & Mishra, 2009)).

When these domains are combined, their interaction generates intersections that give rise to four other types of Knowledge: *Technological Pedagogical Knowledge* (the understanding of how the use and application of certain technologies may change teaching and learning processes (Koelher & Mishra, 2009)); *Pedagogical Content Knowledge* (the methods and practices used by the teacher to adapt the subject matter and content (Koelher & Mishra, 2009)); *Technological Content Knowledge* (the understanding of how content and technology influence each other (Koelher & Mishra, 2009)) and *Technological Pedagogical Content Knowledge (TPACK)* (the understanding of how to teach with technology, grasping how content, pedagogical methods and practices, and the techniques used to teach such content are affected, enhanced or obstructed by using technology (Koelher & Mishra, 2009; Koehler & Mishra, 2008)) (Figure 1).



Although it is widely accepted that TPACK stems from Shulman's (1986) theory of Pedagogical Content Knowledge (Voogt, et al., 2012), its conceptualisation could prove somewhat problematic owing to the multiple developments and ways of understanding TPACK as it has evolved (Voogt, et al., 2012). Nonetheless, Voogt et al. concluded that, despite disagreements on the development of the theory, TPACK was a distinct body of knowledge with an added value, that is, how technology can

support students to learn knowledge that is conceptual as well as procedural. This occurs in different specific subject domains (Voogt, et al., 2012). Owing to the nature of the debate around this subject, Voogt et al.(2012) argued that the functional rather than the instrumental and conceptual perspectives on Technological Knowledge are the most robust for the developments in technology.

Cox & Webb (2004) express some reservations towards Shulman's (1987) ideas which inspired TPACK, arguing that PCK focuses by preference on knowledge, thereby omitting from its theory beliefs and ideas that teachers may hold. This may prove problematic if, as the same authors indicate, for identification of teacher related pedagogies three key components may be required: Values, Beliefs and Knowledge (Cox & Webb, 2004). Such beliefs and values were identified in empirical research (Goos, et al., 2003) as factors that affect the way teachers use technology in the classroom, resulting in such technology being used to reinforce their beliefs (Cox & Webb, 2004). A counterargument, however, may lie in the idea of contexts which are part of TPACK (Figure 1) and may take into account those beliefs which may be considered as a characteristic already present in the implementation of TPACK (Koelher & Mishra, 2009; Ling Koh, et al., 2014). A further criticism of Shulman's method lies in its teacher-centred approach and the notion of fixed knowledge (Cox & Webb, 2004). Nevertheless, based on the empirical evidence, Shulman's views are not discarded, but rather reaffirmed as important within the teacher's realm (Cox & Webb, 2004).

Cox & Webb (2004) feel that, besides what Shulman's theory proposes, it is necessary to consider the 'affordances', that is to say, the possibilities that the environment,

depending on its capabilities, offers the learner. Furthermore, when teachers lack confidence in using ICT, this may be linked to the lack of knowledge of affordances of such technologies in their respective subjects, rather than to a lack of specific abilities (Cox & Webb, 2004). In these circumstances, the role of the teacher is to decide which resources will be more useful for developing students' capabilities, skills and knowledge in a particular context (Cox & Webb, 2004). This approach, they argue, takes into account teachers' and students' Values, Beliefs and Knowledge, which are expected to change with time (Cox & Webb, 2004). But these changes do not apply to all teachers when ICT is introduced. Cox & Webb (2004) indicate that the differences in funding for technology in secondary schools could become problematic, as they may limit access to technology by some teachers.

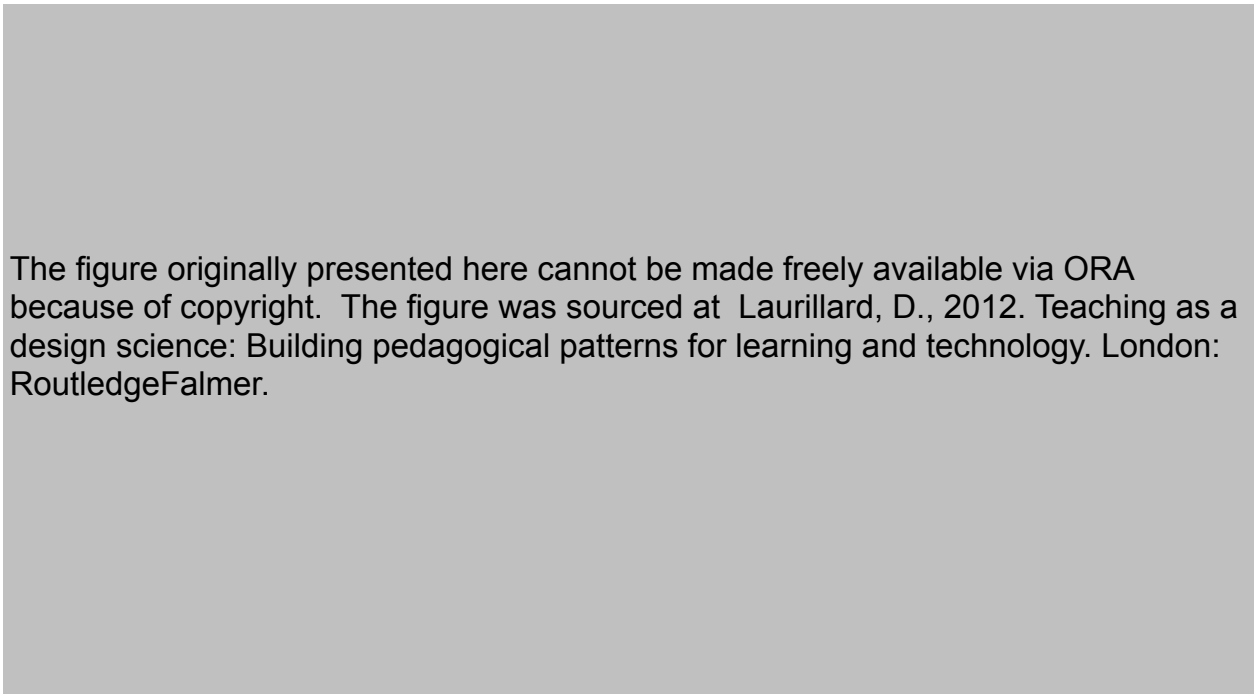
3.2. Laurillard's Conversational Framework

Quite apart from the lack of consideration of the affordances offered by technology, TPACK does not seem to offer a framework for working with different types of media, which could pose problems since, apart from the different kinds of knowledge that teachers must possess to teach with technology, there seems to be no other guidance for its implementation. To solve this, it is suggested that Laurillard's CF offers a multimedia design providing a scaffolding for students that are learning within an environment (Cox & Webb, 2004). Laurillard's approach, therefore, may be understood as complementary to the conceptual developments suggested by TPACK.

Laurillard's (2002) model provides comprehensive ways of interacting with ICT, where she includes the multiple media types (which could be understood as affordances) and a cyclical model to describe how dialogue works in the Virtual Environment. According to Aspden & Helm (2004), she recognises that intellectual development is achieved through interaction and engagement with others. Holmberg (2016) further acknowledges that CF takes into account the interdependence of social and individual processes through an educational design that allows the exchange of knowledge between those involved in the learning process (Teacher, students and peers).

Laurillard's CF uses iterations present in communicative processes and transforms them into adaptive and reflective cycles with actions which have clear goals. This process is aided by feedback facilitating the learning process through self-reflection and self-adjustment vis-à-vis the tasks, as well as the feedback provided by the teacher (Neo, et al., 2013). This process takes place at two different levels: *Firstly*, the discursive level, which involves a process of negotiation between learners and tutors, where learning occurs within their dialogue based on **conceptual or theoretical** principles (what is to be learned). Teachers propose the ideas and concepts and students can question and express their own views in a process of mutual argumentation until a final understanding is reached. *Secondly,* the experiential level, where **actions and adaptation** of the discursive level take place. Here students and teachers go through a process of adaptation. On the one hand, students take the conceptualisations developed at the previous level and put them into practice. On the other hand, teachers modify and adapt the **learning environment** to provide further support to the learners. A successful learning environment must be a working

environment with a task designed with a goal in mind, allowing learners to act on the concepts, and where the **feedback** is meaningful. This would result in the learner's revision of the process and in further adaptation based on the experience (Neo, et al., 2013).



Holmberg (2016) argues that, according to Laurillard (2012), this process takes place in 5 cycles which involve communication at the levels described above (Figure 2). *Firstly,* Teacher explanation and feedback would form part of the teacher's communication cycle. *Secondly,* when discussions about topics take place in the peer group, it would be part of the peer communication cycle. *Thirdly,* application of the concepts involves the teacher modelling cycle, where teachers create an environment in which students have a task to explore. *Fourthly,* the application and modelling that takes places in the students' peer group is understood to be the peer modelling cycle. And *fifthly,* the teacher practice cycle, which is where teachers move between the teacher communication cycle and the teacher modelling cycle to provide students with feedback and support learners' internal cycle of goals, concepts and

actions (Holmberg, 2016; Laurillard, 2012). It is believed that it is in cycles 4 and 5 where the use of technology becomes more significant, as it allows interactions between the different actors in the educational process (Holmberg, 2016). Throughout this process, students and teachers play different roles, and each type of media has a particular functionality to offer to the process of learning and teaching, which Laurillard has classified according to the relationships between different aspects of the learning process and affordances (Laurillard, 2002).

However, Laurillard's proposal was designed for HE in mind and there is no evidence as to how this may work in secondary schools. Additionally, CF's high level of complexity may mean that it cannot be fully implemented in the school context, particularly when combined with different levels of teachers' mastery of the use of the VLE, at it becomes a problematic point. Additionally, as long ago as 2004, Cox & Webb (2004) expressed reservations regarding Laurillard's proposal, as her design for multimedia was not regarded as a commonplace in educational software. However, it could be argued that CF enhances TPACK and gives it the structure that it might otherwise lack when it comes to its implementation. Moreover, it may prove useful for encouraging dialogue and interaction between teachers and students on digital platforms. This dynamic has already been established among university teachers and students employing CF (Neo, et al., 2013).

3.3. Project Framework

Based on the theoretical frameworks explored above, a framework was created for this project's interventions which were planned by intertwining the three main

pedagogical approaches explored (using blended learning). However, although in theory it is possible to establish clear-cut distinctions between the interactions of such approaches, in practice it is more complex, as such interactions occur naturally and move from one level to another. For the purpose of the interventions planned in this research, it will be argued that the three approaches interact in the following way (Table 1 and Figure 3):

Stage	**First intervention**	**Second intervention**	**Third intervention**
Assumption	Associative perspective	Cognitive perspective	Situative perspective
Tasks designed according to TPACK	TK: Setting homework on the VLE TK: Creating self-marking quizzes	TCK: Creating Task Lists on the VLE TPK: Considering what things, specific to the subject, can be implemented using the VLE.	PK: Using rubrics to plan task lists. TK: Using forums to discuss topics with students. TPACK: Creating their own tasks lists using rubrics and the VLE affordances.
Media affordances used according to the CF	Videos, forums, self-marking quizzes.	Videos, forums, self-marking quizzes.	Videos, forums, self-marking quizzes, homework.

Table 1

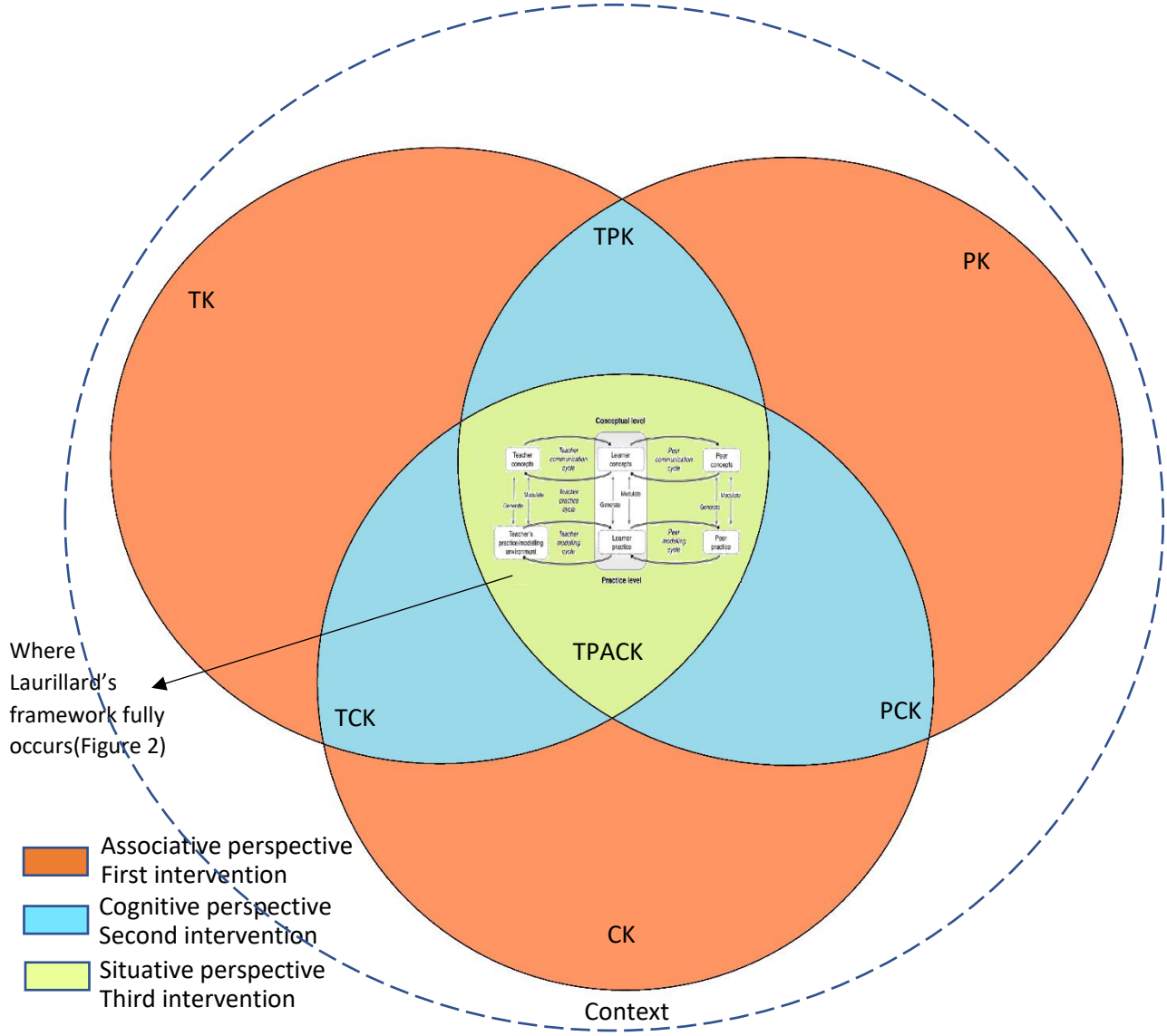

TK
TPK
PK
TPACK
TCK
PCK
CK
Context
Where Laurillard's framework fully occurs(Figure 2)
Associative perspective
First intervention
Cognitive perspective
Second intervention
Situative perspective
Third intervention

Figure 3

4. Research Question

The review of the literature reveals significant opportunities for using Blended Learning with the aid of platforms such as the VLE. One of the benefits, it is argued, is that students make more significant progress while developing their independent learning skills. However, it is also revealed that poorly evidenced claims, a lack of training relevant to the subjects or the mere introduction of technological 'tips' for teachers may jeopardise the added value that such technologies can bring to the classroom. This combination of findings, supplemented by discussions with other teachers showing that self-positioning, colleagues' beliefs and an apparent lack of interest in the technological affordances provided by VLE, led me, as the school's VLE and Website Coordinator, to develop meaningful questions which would inform and define this study:

Main Research Question

How can the development of teachers' Technological Pedagogical and Content Knowledge be supported in a whole-school intervention?

Research Sub-questions:

- What are the impediments faced by teachers to the use of digital technology in the classroom? (RQ1)
- How do students perceive teachers' use of Technological Knowledge as a tool for supporting their learning? (RQ2)
- How do different departments interact with educational technology such as the VLE and develop Technological Pedagogical and Content Knowledge to support students' learning? (RQ3)

- How can a department-based whole-school intervention approach support the development of teachers' Technological Pedagogical Knowledge? (RQ4)

5. Research Design and Interventions

Bringing theoretical frameworks and evidence-based studies from elsewhere might present problems, as it may not work in particular contexts and challenging teachers' beliefs may also prove difficult (Cordingley, 2004). Consequently, careful consideration was given to how best to answer the questions presented above. Thus, a dialogical (research-practice) process involving a user-centred model, where the practitioner uses his/her own knowledge and perspective to understand and inform his/her teaching practice, was considered beneficial, as in evidence-informed education this process creates networked spaces between theory and action (Cordingley, 2004). This encouraged me to design this study from a small-scale practitioner study perspective (Fox, et al., 2007). The steps for design of the research and the rationale for the formulation of the Research Questions (RQ) can be found in Table 2 and 3. Such steps were not linear, however, and there were some processes that were developed in parallel and others required revisiting previous stages of the design. Further exploration of how this relates to the instruments and collaborators will be made in the following sections.

Events which inspired the design of this study		
• June 2018: I was made the VLE and Web Site Coordinator at School. • July 2018: When discussing strategies for implementation of tools from the VLE, I encountered teachers' resistance. • Literature suggested that teachers face some impediments when asked to work with technology.		
RQs	**Rationale for RQs**	**Key findings in the literature that aided design**
RQ1	-Identify how far the findings from the literature were present in my current school context. -Identify elements that needed to be addressed when planning the interventions.	-Literature suggests that teachers' self-positioning and their beliefs influence their use of ICT. -Training could work as a strategy to challenge beliefs and self-positioning
RQ2	-Explore students' views on teachers' TK, as well as their perceptions on how this TK (particularly the VLE) supported their learning at different stages of the research process.	
RQ3	-Verify the findings of the literature review in my current school. -Inform the process of intervention per department to identify how each one of them approached the affordances offered by the VLE.	-Literature suggests that different subjects interact in distinct ways with ICT. -Training recommended as a strategy. -Using TPACK and Laurillard's CF as bases for the design of tools for training. -Despite the lack of academic research on effective ways of training teachers, this is regarded as an effective way of having a dual impact on the use of technology such as the VLE. It should promote both teachers' and pupils' engagement.
RQ4	-Evaluate and critically review the effectiveness of the whole-school intervention process using TPACK (with the modifications made and explained in the following section).	

Table 2

Months and activities	Data collection	Interventions and times	Collaboration activities
October			-First collaborators' (Teaching, Learning and Assessment group (TLA)) meeting to agree and plan collaboration.
November			-Second collaborators' meeting to discuss and pilot questionnaires and interviews. -Collaborators were offered a three-hour training session on the use of the VLE by the end of November, conducted by mylearning.com.
December	-First interview with teachers conducted. -Introduction of a researcher diary.	-Morning briefing introducing the VLE and its tools.	
January	-First interviews with teachers (continued). -Students' questionnaire applied. -Researcher diary: ongoing.	-Jan to Feb 2019: First intervention (Subject-based teacher training using the VLE). -Creation of a framework for the implementation of the interventions. -Creation of the task list for the training -In January the 'task list' created to train teachers was nearing completion and was discussed, but it was not used by collaborators to train their departments. Instead, they decided to employ other techniques first and then use the task list later to reinforce training.	-Third collaborator's meeting and discussion of answers to questionnaires and initial interviews. -The stages for implementation of the whole-school interventions were discussed at our TLA meeting in January 2019. -Collaborators to deliver their training sessions at the times they find suitable (Out of the four collaborators, three led training sessions with their own departments and two supported other subjects (Art: Art and Performative Arts and ICT: ICT and DT)).
February	-First students' interviews conducted.	-Morning briefing on using the VLE for marking led by Collaborators.	
March	-TPACK questionnaire applied.	-Second intervention (Subject-based teacher training using the VLE). -Morning briefing on the content library and organising files on the VLE.	
April			-Fourth collaborators meeting to check findings and discuss further training or interventions.

May	-Second interviews with teachers conducted. -Second students' interviews conducted.	-Final intervention*. Date agreed for 1st May.	-Collaborators contributed by sharing their own account of how the process of training teachers using TPACK worked and of the reactions perceived within their Departments.
June		-Final intervention*(It was moved from 1st May to 19th June).	-Fifth collaborators' meeting to have final discussion of findings. -When the results were available, they were examined with the collaborators who assisted with the interpretation of data.
July	Researcher diary notes reviewed.		
* the date was modified			

Table 3

5.1. Interventions

In this section I will outline the original plan for interventions that were put in place, and then I will explore some adaptation required owing to school dynamics. The adaptations will be presented on two different levels: the organisational level (planning and instruments), and the practical level (how the interventions developed and how effective they appeared to be).

5.1.1. Original Plan

For implementation each of the collaborators had the freedom to train their Departments when they considered it appropriate. For my part, I had to book different meetings on Wednesdays after school (each lasting 30 minutes), taking place twice

with each department (Table 3) (Modern Foreign Languages (MFL), Humanities, Science, Religious Education (RE), Maths, English). All emails requesting specific dates and times were sent out.

A task list (An example is found in Figure 4 and Appendix 2 (Video)) was created to train teachers on using the VLE, and it allowed me to use different media as envisaged by Laurillard's CF such as narrative sources, videos etc, that are controllable by the teachers (in this case in the role of a student), making it more adaptable. This task list was the same for all departments, and it was expected to be adapted in discussions and by teachers using their PCK.

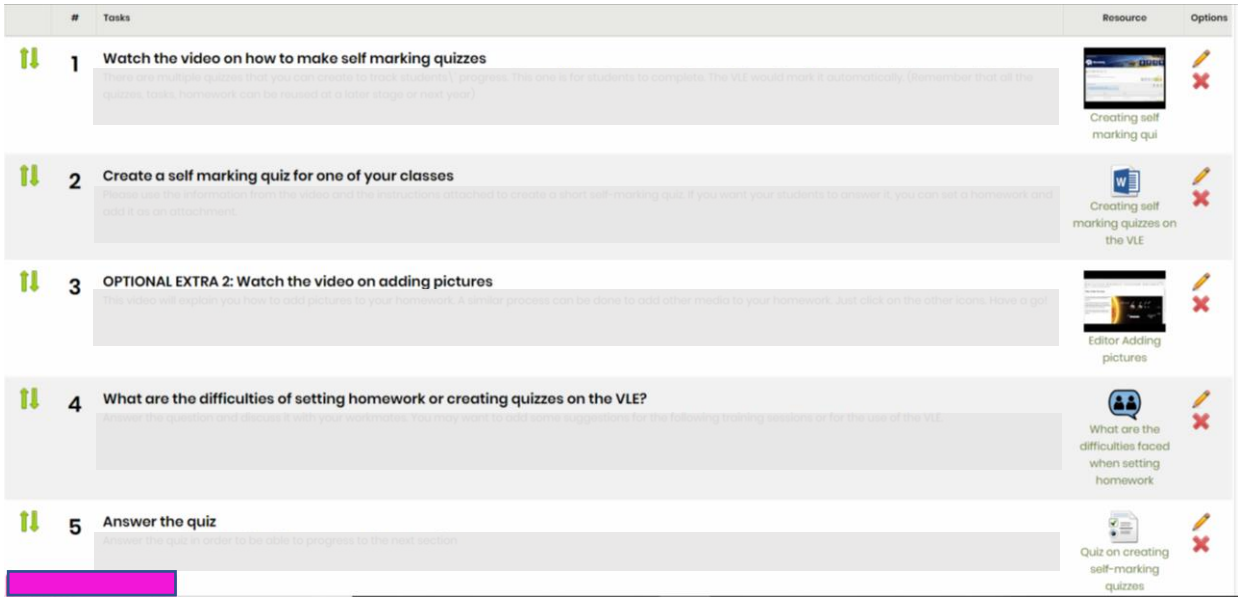


Figure 4

One of the benefits of this method was that each teacher could progress through the training at their own pace, while transforming their ideas into products (Goodhue & Thompson, 1995). Each training intervention (or session) had a similar structure (using

blended learning) aimed at helping teachers familiarise themselves with the tasks set. The original intention was to create a single task list divided into three parts (one for each intervention or session), with the following affordances: *Firstly*, a video provided by mylearning.com which explained all the steps for specific tasks they were being asked to perform (i.e. Stage 1: Assign homework and self-marking quizzes. Stage 2: Creation of task lists. Stage 3: Creation and use of forums). There were some optional videos for those teachers who might wish to explore other properties of the VLE (i.e. how to drag and drop files on the VLE, how to add pictures to homework and other tasks and how to give feedback in a form). *Secondly*, Word files with instructions regarding each task they had learned were provided. This was done to assist teachers who needed to revisit particular tasks but did not want to watch the videos again. *Thirdly*, forums for discussion of the tasks undertaken were created. The idea behind this was to facilitate dialogue and collective work online. *Fourthly*, quizzes to assess their progress, where teachers had to get at least 70% of answers correct to progress to the following stage. Additionally, towards the end of the training there was a homework task for teachers, in which they were encouraged to design task lists for their students. This was intended to allow them to put their learning into practice.

Other opportunities were provided by the SLT(Senior Leadership Team) to lead some sessions during morning briefings, in which we offered two basic affordances of the VLE and a task (Appendix 3). The primary intention of these sessions was to complement the training provided in Departments and to share good practice in the use of the VLE.

5.1.2. Adaptations

At the organisational level, soon after the emails were sent, it became clear that booking the training would not be straightforward. Although many heads of department (HoD) confirmed the dates for intervention, others had to meet previous commitments, and asked me to rearrange the dates, owing to multiple reasons such as clashes with dates where reports were expected, staff being absent, *inter alia*. Dates were modified for English (none of the interventions took place), RE (the second intervention was not completed), Science and Maths, too. Many training sessions had to be booked on a different Wednesday, to take place after finishing training with other departments. And the third intervention (when all the subjects came together) was moved to 26th June.

At the practical level, *on the one hand*, collaborators did all the training for the three stages (from the original plan) in one session, and they decided to do this without the use of the task list planned (which was not completed for our meeting in January (Table 3)). However, later on they used the final task list to reinforce any learning in their department. *On the other hand,* the training sessions that I led with the different departments became a very dynamic process with multiple things to consider. *Firstly,* the department-based approach meant that negotiations with HoDs had to take place according to the time they were able or willing to provide. *Secondly,* the platform was highly useful for tracking the progress of teachers, letting me see how some teachers and departments were finishing my tasks before the time I had allowed them.

Thus, for those who had already finished all the original task list during session one, a new task (for session 2) was prepared (using the principles of the framework). They were asked to create their own task list using the skills learnt during the training (Figure 5). In this second session the way in which teachers interacted with this initiative in each department developed mainly in three ways. *Firstly*, some subject-areas spent their time completing the original task list. *Secondly*, other subjects started with the task and ended up discussing ways to incorporate it into the subjects. *Thirdly*, progress in other departments differed from teacher to teacher, which meant that some teachers were completing the original task list and others were doing the practice task prepared for session 2.



Figure 5

After modification, the third session was intended to explain the theoretical framework to teachers and show how it could work in practice. For this, some examples of work done with blended environments (using already created webquests as an example) and teachers' knowledge and experience to produce tasks were presented (including using rubrics to plan clear objectives and assess the value of the affordances of the tools for the tasks desired). This was done also to target some of the problems and opportunities identified when teachers created task lists; for example, many of them were not regarded as processes to be developed, but as a single task for the students.

5.2. Ethical Considerations

The regard for ethical considerations stems from the fact that this study is concerned, and works with, human participants, requiring particular attention to ethical issues that may arise and ensuring that all participants are safeguarded. To comply with these, an application stating the title, RQs and the possible course of action was first of all submitted for ethical approval to the Central University Research Ethics Committee (CUREC) (Appendix 4). Following approval, and prior to commencement of research, my Head Teacher was presented with a letter outlining the study and the aims of the research (following the University's modus operandi) and seeking his consent (Appendix 5).

Other specific measures were then taken to obtain consent from teachers and students at the start of the study (Table 4).

Instrument / purpose	Ethical consideration	Way in which the ethical consideration was addressed
Invitation for teachers	To make teachers aware of what the project involved (BERA, 2018)	A brochure (Appendix 6)
Students' interviews	To request parents' consent	A letter of consent (Appendix 7)
Online questionnaires	Confidentiality, not-traceability and anonymity (Cohen, et al., 2018; BERA, 2018)	Use of the VLE for online questionnaires, as it permits the creation of anonymised surveys. Any information about the interviews or the questionnaires shared with collaborators was previously anonymised and pseudonymised (BERA, 2018).
Interviews and online questionnaires	Right to withdraw consent at any stage without providing any reason (Cohen, et al., 2018) and to know the aim of the survey (BERA, 2018)	Students were reminded about their right to withdraw at any stage at the beginning of each survey (Appendix 8).
	Neutrality, methodological rigour and fairness (Cohen, et al., 2018)	Surveys were piloted with the collaborators group.
	Time strain on respondents (Cohen, et al., 2018)	Ensuring that interviews and questionnaires were short in time (Lichtman, 2013).
Interviews	Disclosing information if illegal or dangerous activities were found	Participants were made aware of this situation, following BERA's (2018) guidelines.
	Researcher-interviewees power relations (Cohen, et al., 2018)	To make the role of researcher explicit from the beginning of the interviews (BERA, 2018). Questions were tailored to address this situation.
	Overfamiliarity (Lichtman, 2013)	Maintain professional standards during the whole process.
Recording of interviews	Safe data storage (BERA, 2018)	Recordings were encrypted on my laptop. I tried to use the University of Oxford backup system (HSF), but this was unsuccessful, owing to technical problems.

Table 4

It is worth mentioning that the way in which teachers engaged critically with the interviews and interventions suggests that they spoke openly and honestly. This could be because I am not a senior leader, and this may have reduced the researcher-interview power relations presented in Table 4.

An unexpected situation arose, however, owing to my being both a researcher and a teacher. My line manager asked me to include a question in the students' survey regarding parents' involvement, specifically on report checking. Although it did not form part of my research, I considered that the question did not on the whole represent a breach of ethical considerations, given my position as VLE coordinator.

However, as this was not part of the original research, it still presented me with the difficulty of differentiating between my roles as researcher and practitioner.

5.3. Collaborators

The TLA group(organised by the Assistant Head for Teaching and Learning) was formed from those who volunteered to work in the VLE. The group was composed of teachers from the following departments: Arts, Music, ICT and Business. During the first and second meetings (Table 3), they were informed of the possibility of my conducting a study on the VLE as part of my Master's. Subsequently, they were consulted on their willingness to participate as collaborators and on the option of my using the minutes of our meetings to inform this research. They agreed to take part, to help develop and lead some of the interventions (Table 3). They also gave permission for the minutes of the meetings to be used as material for collecting data for this study.

Despite this, time constraints were evidenced when booking extra meetings for discussing progress was not possible, suggesting that the process of collaboration was not uniform. Nonetheless, this issue facilitated compatibility and showed differences in the departments' progress when the framework was fully used and when it was only partially used.

5.4. Participants

Most teachers at my school were involved in the project. For instance, all teachers (excepting Physical Education, owing to conflicts with their timetable and

extracurricular activities) took part in the three main interventions. For the interviews with teachers, all interviewees were invited to participate and volunteered to take place in this study. A teacher from each of the subjects: English, ICT, Maths, Humanities, Science, Religious Education, and two from Modern Foreign Languages, volunteered. A further group of teachers took part in a midpoint anonymised questionnaire based on a TPACK survey. A total of 9 teachers out of 83 (equivalent to 11% of the teaching staff population) participated in the survey.

A similar process of selection was adopted for students, where one group was also interviewed at two different stages (Table 3), with no specific criteria for their selection other than their willingness to participate. There were four pupils from year 9, one from year 11 and one from year 12 and a year 7 pupil who could not take part in the first interview owing to a sports competition. Five of the participants were females and one male. These students were those who came forward after a wider group was invited to take part. One further anonymised questionnaire was applied to all students at school. Although participation was voluntary, a total of 110 out of 843 students (equivalent to 13%) took part in the survey.

5.5. Instruments

As outlined above, this is a small-scale practitioner study employing mixed research methods (Gorard & Taylor, 2004), incorporating interviews (Appendix 9) and a researcher diary (Cohen, et al., 2018; Ary, et al., 2010) from qualitative research, and online questionnaires (Appendix 10) from quantitative research (Cohen, et al., 2018). The aim of this choice was to offer a wider range of methods which would hopefully

allow me to triangulate data gathered and add rigour to the study (Cohen, et al., 2018) (Intentionality of instruments, Table 5).

Instruments	RQ targeted	Purposes of the questions within the instrument
First Teachers' Interview	RQ1	Aim: to discover impediments to and opportunities for training. • Q1, Q3, Q8, Q10: Beliefs • Q2, Q3, Q10: Impediments and opportunities/affordances • Q4-Q5: Use of technology in general/TPK, department-based use • Q6-Q7: Use of the VLE specifically/TPK, department-based use of the VLE • Q9, Q11: Training
Teachers' Questionnaire (TPACK)		Aim: to ascertain teachers' self-perception of their mastery of the different knowledge present within TPACK, with emphasis on technologically related knowledge. • Q1-Q6: TK • Q7-Q9: CK • Q10-15: PK • Q17: PCK • Q18: TCK • Q19-Q27: TPK • Q28: TPACK
Students' Interviews	RQ2	Aim: to collect students' perceptions of teachers' use of technology in the following categories: • Q1-Q2: Beliefs/relationship with technology. • Q3-Q5: Impressions of teachers' TPK. • Q6-Q9: Use of the VLE and beliefs underpinning those practices. • Q10: self-reflection from the students' perspective on their use of technology. • Q11: openness to development and opportunities for encouraging teachers to use technology
Students' Questionnaire	RQ2	Aim: to collect students' perceptions about teachers' use of technology. <u>Part 1</u> • Q1: Use of technology in general • Q2: Use of the VLE specifically • Q4: Use of the VLE's affordances

		• (Q3 in this questionnaire was suggested by the VLE line-manager to identify parental support for the platform. It is not directly relevant to this project) • Q5: Open question to establish what technology was used by teachers. <u>Part 2</u> • Q1: Improvements in using technology by teachers. • Q2: Changes in using the VLE. • Q3: Identify subjects that used the VLE more often/effectively.
Teachers' Second Interview	RQ3	Aim: to document any impressions teachers had during the training, as well as suggestions. • Q4: Subject interaction with training. • Q8: Implementation of learning from training in subjects. • Q9: Subject specific use of the VLE during the training. • Q10: Subject specific use of technology.
	RQ4	• Q1: Value of Blended Learning for teaching. • Q2, Q3: Value of training provided. • Q5: TK and training. • Q6: Effectiveness of the training for improving TPK • Q7: Suggestions for further training/evaluation.
Researcher Diary and minutes of TLA meeting	RQ1 RQ2 RQ3 RQ4	Aim: to inform this study from everyday experience.

Table 5

Regarding the interviews, scholars discovered some issues related to this methodology. *Firstly*, notwithstanding efforts to be systematic and objective, subjectivity will necessarily be involved, both in the relationship established (interviewer-interviewee) and in cultural influences, in the interpretation of data etc. *Secondly*, simply being the researcher puts me in a situation of power (Cohen, et al., 2018). To address this issue, I opted for the use of qualitative semi-structured interviews (Wilkinson & Birmingham, 2003; Bell & Waters, 2014; Ary, et al., 2010), combined with the interview guide approach (Cohen, et al., 2018), with a view to constructing a more flexible style, whilst maintaining a clear structure. This means

that the planned questions and their order are likely to be modified as the interview develops (Cohen, et al., 2018). I considered such modification to be beneficial, as I believed it would help to balance the use of power by ceding some control of the answers to the interviewees (Cohen, et al., 2018). I am conscious that close quantitative interviews offer a more systematic gathering of information which renders analysis easy, but they also limit the way respondents interact and give information (Cohen, et al., 2018). My hope is that by attempting to provide this balance in the choice of methods, I might guarantee some comparability, without removing too much spontaneity.

A further point is that, although group interviews are regarded as beneficial in terms of time and of the interactions they facilitate (Ary, et al., 2010; Cohen, et al., 2018), teachers were interviewed individually, owing to multiple factors. Firstly, it was somewhat difficult agreeing on a single time to meet for the interviews. Secondly, some teachers confessed to feeling more at ease being interviewed as an individual rather than as a group. Thirdly, it was believed that it would allow teachers to share personal and different views (Cohen, et al., 2018). This final point was regarded as extremely significant, as it is highlighted in the literature review that teachers' beliefs play a fundamental role in implementing technological platforms.

Students, on the other hand, were interviewed in focus groups, the aim being to record their experiences as a homogeneous sampling, and the number of participants (only six pupils) aided this choice (Ary, et al., 2010). As they were younger, it was also felt that listening to others would help them to form their own opinions and thus allow several viewpoints to be considered on using technology and the VLE. This

approach was also expected to provide flexibility and comfort for students (Ary, et al., 2010).

As regards questionnaires, they offered the possibility of participation to those who did not necessarily feel comfortable answering articulate interview questions (Cohen, et al., 2011), whilst complementing the open questions of the interviews, facilitating triangulation. The models chosen were structured questionnaires with Likert-type (or rating scales) questions (Wilkinson & Birmingham, 2003; Cohen, et al., 2018), designed to prevent drift in the answers while adding flexibility. To avoid clustering of responses (Cohen, et al., 2018), I opted for 'forced choices' by omitting the middle category (neither agree/disagree), but I am conscious that this option renders the survey more dichotomous (Cohen, et al., 2018). Although this may make it difficult analysing questionnaires and interpreting data, I also attempted to introduce further flexibility by adding one open-ended question to the students' questionnaire (Cohen, et al., 2018).

There were two further pieces of information used in this study. *Firstly*, diary entries were used to inform the process of implementation and to capture those pieces of information (Cohen, et al., 2018; Ary, et al., 2010) that formed part of teachers' and students' everyday practice. Owing to the lack of events on some days, weekly entries were chosen in preference to daily entries. *Secondly*, the collaborators' meetings were recorded in minutes in which specific items and tasks for discussion were entered. The purpose of the latter was to understand the process of collaboration and how it developed over time.

5.6. Data interpretation

For the selection of data from qualitative resources, there being no agreed strategies for coding qualitative data (Lichtman, 2013), I followed Lichtman's (2013) 'six step movement' progressing from codes to categories and then producing concepts. This allowed me to systematise all the records from the interviews (using some functionalities of Nvivo software), the meeting minutes and the researcher diary (Table 6 shows the instruments, the categories per instrument and the final concepts used to code data). For the final interpretation, I worked in a dialogical process between questions, data and meaning (Lichtman, 2013).

Instrument(s)	Categories	Concepts
• **First teachers' interview** • **Teachers' questionnaire**	**Impediments faced by teachers to using digital technology in the classroom**	• Teachers' TPK • Beliefs • Training • Affordances • Time/Workload • Other impediments
• **Students' interview** • **Students' questionnaire**	**Students' perception of teachers' use of Technological Knowledge as a tool for supporting their learning**	• Teachers' ability • Technical problems • Teachers' use of the VLE • Task replicates similar assignments offline • Other impediments
• **Second teachers' interview**	**Interaction of different departments with educational technology such as the VLE to support student's learning**	• Teachers' TPK in each subject • Subject-based beliefs • Affordances existent or perceived for each subject • Experience

• **Second teachers' interview** • **Researcher diary**	**Effectiveness of a department-based whole-school intervention approach support teachers' TPK**	• Impressions of training • Experience/Usefulness • Department-based approach/Framework • VLE as a way to train teachers • Suggestions

Table 6

The students' questionnaire responses were codified and tabulated, and the breakdown of responses expressed as a percentage to facilitate reading and comparison. The teachers' questionnaire, owing to the amount of questions and the rationale for its use, was transformed into a graphic. This allowed me to compare those instances where TK was used and how this compared to the other knowledges in TPACK.

Finally, to produce the final interpretation, data was triangulated (Cohen, et al., 2018), with the aim of using both qualitative and quantitative data to be 'mutually illuminating' (Creemers, et al., 2010), employing the codes gathered as a base. This, I believe, permitted a cyclical process in which the information gathered for this research could be used to facilitate deeper understanding (Creemers, et al., 2010) of the questions posited.

6. Study

The following sections present the findings in the light of the relevant literature. For this, the various subsections focus on respective RQs suggested for this study.

6.1. Impediments faced by teachers to the use of digital technology in the classroom

Figure 6 (Full tabulation in Appendix 11) shows that, in the online questionnaire, when teachers were asked about their PK and CK, their responses were positive, with most of them agreeing or strongly agreeing that they felt they had some strong knowledge of them. However, when questions involved any kind of TK, teachers' negative responses grew (disagreeing or strongly disagreeing). This, combined with the interviews, suggested that teachers at my current school faced challenges when working with technology, as per the Literature (e.g. self-positioning, lack of confidence etc.) (John & Wheeler, 2008; Lyndon & Hale, 2014; O'Mahony, 2003; Becta, 2004; Nikolopoulou & Gialamas, 2016; Thorsteinsson, 2013). Some of these challenges informed the planning and implementation of the interventions, whilst others lay beyond the scope of the present study. Of those used to inform the interventions, the following were significant: skills and workload-time, teachers' resistance towards ICT, self-positioning and belief in a generational divide which leads to lack of confidence in the use of technology, lack of training, lack of pupils' engagement, and lack of teachers' and students' familiarity with ICT (all of them intertwined). Those issues lying beyond the scope of this study include the cost of technology and lack of

technological tools.

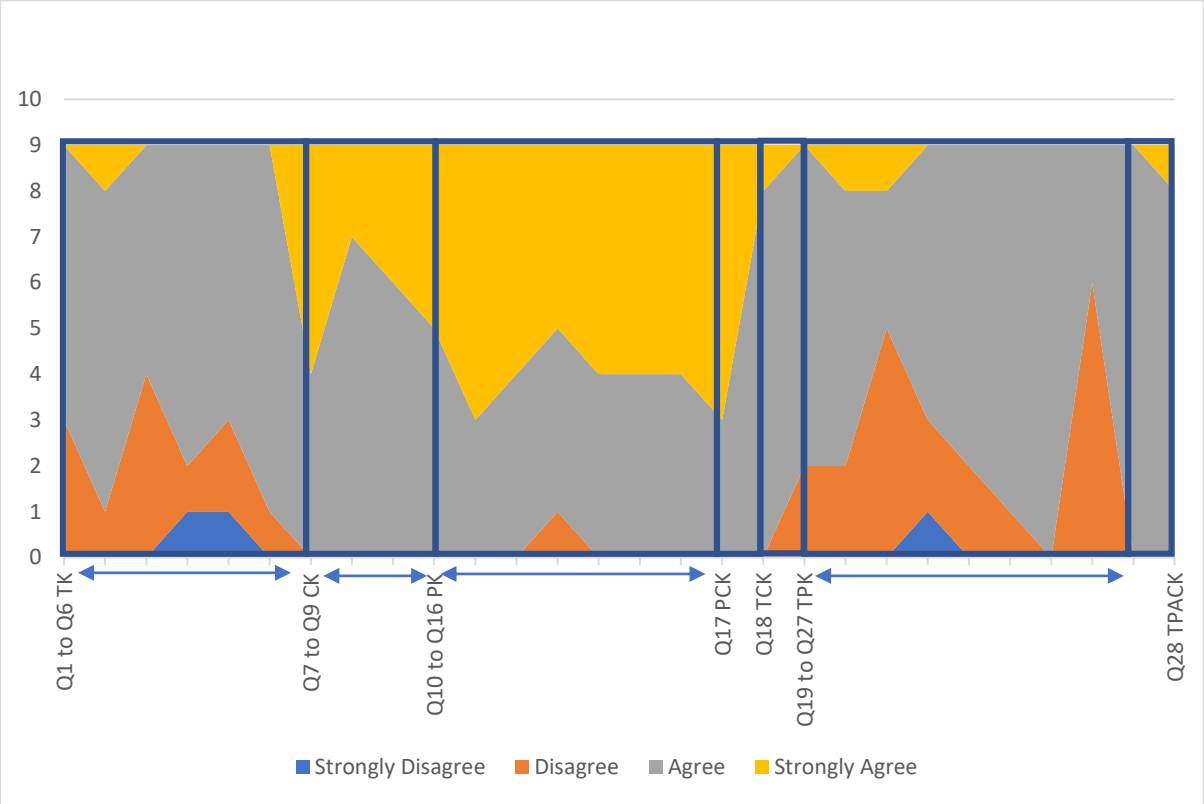


Figure 6: TPACK questionnaire(Teachers)

Concerning the former: *Firstly*, the time spent on learning and mastering ICT skills was considered to be an issue, which matched the findings of the literature (Becta, 2004). This was expressed by many teachers. For example, M argued that the training offered for implementing the tool had to be meaningful.

> *If you want to do something and you don't know how to do it, it's time consuming and you need to be with someone who knows what they're doing… because time is very precious as a teacher...*

Some teachers, in the initial stages of the process, felt that the VLE as a technology would increase their workload, as in the case of G:

> *[A]t the moment, it increases [the workload]... If I am setting a homework on the VLE. I would have to take that extra step to upload the homework task…*

But overall, most teachers appeared to consider that time invested in developing TK to manage the VLE would later be balanced, as students would not be asking for materials which would be readily available on the VLE, as D states:

> *It would… reduce my workload. I would not have all these students asking me for materials that could already be there[on the VLE].*

Secondly, in line with Weller's (2007) findings, for some teachers, technology evokes more resistance than enthusiasm, not only owing to the need to acquire additional pedagogical skills, but also because of the failures that can come with using technology. As expressed by N:

> *[T]echnology often lets you down… and it is really frustrating when you plan a lesson and... the page won't open or you lose connection with the internet, I just think... why don't we just go back to reliable technology like an overhead projector. You can't go wrong...*

This, however, is regarded by some teachers as a lack of ability and the wrong attitude when problems occur. It is more about attitudes and thinking about ways to solve them, rather than simply renouncing it, as suggested by Grey (2001). In this connection, L argues:

> *I find people get frustrated with technology... they want [it] instant, but then... it takes a couple of minutes - just step back, reassess what's going on…*

Thirdly, there also appears to be a lack of confidence or competence (Section 2.2.1) which fosters resistance, echoing John & Wheeler's (2008) claims. This is also to some extent linked to the issue of self-positioning and other beliefs which may affect the way teachers interact with ICT (Cox & Webb, 2004). It was particularly interesting to see how N believed his students perceived his use of technology:

I think, that they think, that I was a bit of a dinosaur.

Besides this, N seems to see himself as part of a generation which lacks the ability to use technology in an intuitive way:

> *It's unrequited love… I am not very good with technology. I am too old. I think I am of that generation… it's not intuitive with us… when you are brought up as a child and you… grow up with it, it is much easier*

This could suggest that those views presented by Prensky (2001a; 2001b) about a generational divide, despite overwhelming academic evidence to the contrary (Helsper & Eynon, 2009; Bennet, et al., 2008; Bennet & Matont, 2010; Margaryan, et al., 2011; Foote, 2008), appear to have filtered into society, as socio-historical beliefs that affect the way in which teachers view themselves when faced with technology. This is proposed because N is not the only one who holds such views. In fact, they are shared by younger teachers such as G (the youngest member of staff who was interviewed):

> *I think that I am a bit better at taking on technology than maybe someone who is a bit older than me… I do think that age does affect your approach to technology.*

However, going beyond the notion of beliefs, the practical use of ICT by teachers who believe in the generational divide seems to contradict their self-perception. In the case of N, his dexterity using technological tools is greater than he claims it to be. When he was asked about the way in which he used technology, he responded:

> *Well, I use a lot of audio-visual stuff for teaching languages… Activelearn… and mydynamiclearning[1] [are] good because [they have] got a lot of visuals... occasionally I may show a YouTube clip...*

The interesting thing here, however, is how N (and other teachers surveyed) are using tools that make them technological users (Helsper & Eynon, 2009), but they are still regarding themselves as non-technological users. This self-positioning, however, is not a general trend with all teachers and some of their feelings reflect Foote's (2008) findings, according to which there is rather an array of abilities (non-age-based), as well as those of Helsper & Eynon (2009), who claim that experience and breadth of use are what really matter where the level of confidence and use of technological platforms are concerned. For instance, M believes that she has yet to learn more:

> *I'm OK with… spreadsheets, PowerPoint, Word, Internet… [but…] there are bits I'm still not… confident with. So, editing spreadsheets with look ups and things… I'm still learning….*

Or MF, who feels confident using technology but has yet to implement it fully in the classroom:

> *I use… lots of technology outside of the classroom. It's okay in teaching... but I do know that there are quite a few areas where I could use more.*

Fourthly, in both of these cases, and in accordance with Goodwyn & Findlay (2003) and Becta (2006), it was found that teachers view training as important for the successful implementation of technology in education, but if such training is

[1] activelearn.com and mydynamiclearning.com are online platforms which contain digital tools for different subjects.

done as a whole-school initiative, where all teachers take part at the same time, it is seen as inconvenient. Furthermore, small groups and one-to-one support are preferred. On this N argues:

> *I don't feel that we've had the proper training… we are in a room of sixty people and they flash through things, the screen is a long way away… and then you get lost. So, unless someone sits down with you in a small group, and you have a laptop, and you can actually do it... I can't learn that way.*

Additionally, if training is irrelevant to teachers' contexts, it tends to be highly criticised by teachers for appearing disengaged from their practice. N further argued:

> *The problem with learning how to use the computer is unless it is relevant to you at the time, it does not stick in your mind.*

These ideas from the interviews (and the literature) influenced the decision to use department-based training for the interventions. Furthermore, besides those ideas expressed by N, some members of staff displayed scepticism, as they felt that, in accordance with John & Wheeler (2008) and Lyndon & Hale (2014), training sometimes did not connect with the pedagogy. This was observed in one of my early conversations with a technologically savvy member of staff who was invited to participate in this research:

> *He… was dismissive and told me that he would not take part in it… he mentioned… that training for using the VLE had become somewhat repetitive*
>
> (Researcher Diary October week 4)

Fifthly, although teachers may dislike feeling undermined when managing technology (as per the literature review), some do not mind asking students for help when it comes to technology, as in LM's case:

> *They would say I could show her quite a few things. They do help me if I need it.*

Sixthly, following suggestions such as those from Becta (2004; 2006), we targeted teachers' training, hoping that it would improve student engagement. However, this research suggested that focusing on both teachers and students is necessary, as most teachers reported a lack of students' engagement, which may prove problematic when trying to promote the VLE. On this LM says:

> *Students don't want to link onto it. They forget the passwords or some of them pretend to go… and look at the homework… but then actually don't do it.*

But this may be linked to the fact that most subjects are still using the VLE as a means to deliver information (Lyndon & Hale, 2014).

Overall, despite the six impediments above, teachers felt inclined to learn about technology and to spend time on it insofar as the training was relevant and it avoided extra complications and passwords, as expressed by LM:

> *I like technology but I'm not very good at it. I don't mind trying out new things… I don't mind as far as it is not an awful lot of passwords and… logins.*

As for the challenges that lay beyond the scope of the study, little could be done to address them. For example, L's perception that the costs of using and implementing technology are too high, even for his department (ICT), and could become an issue for developing expertise in the use of technological platforms:

> *Technology... is so expensive. There's a lot of technology I would like to purchase, but again it's the cost element… If we needed it as part of the curriculum, it wouldn't be an issue.*

Such costs may create a lack of technological infrastructure, which in time would affect the development and engagement of teachers with ICT. For instance, technologically driven teachers reduced their use of technologies owing to problems of access. Their ideas reflect what was perceived to be a problem across the board with the different interviewees. For example, R argues:

> *I don't use [it] very much because of the lack of access to technology in this particular school.*

This study showed that ICT presents teachers with particular challenges which, in general, echo those suggested in the literature review. For example, a lack of equipment and some beliefs which lead to self-positioning or to accepting technology in a particular way or to rejecting some technological tools altogether, thus affecting teachers' self-efficacy and belief in their own skills (Bandura, 1997; Underwood, 2007). Although obstacles such as the lack of equipment still influence beliefs and self-positioning, this is something that can only be addressed by implementing new technology, which may be considered notoriously difficult owing to the current school cuts, but this is a matter for future research. Concerning self-positioning, this current study has found that training may have an impact on changing teachers' beliefs about using technology. However, the evidence is still inconclusive and further research is necessary in this area.

Generally, most teachers are willing to engage with training if it represents real benefits. Some teachers, however, still find using ICT frustrating, for various reasons. This could perhaps be linked to the lack of confidence and competence of teachers,

who may also have underlying beliefs (individual and collective) which reinforce their self-positioning. However, evidence suggests that teachers' practice did not match these beliefs and instead demonstrates that all teachers used several technological tools. Finally, the lack of student engagement needs to be addressed. On this, merely training teachers did not prove a sufficiently effective strategy for driving pupils' engagement, and further investigation in this area is required.

6.2. *Students' perception of teachers' use of Technological Knowledge as a tool for supporting their learning*

This section explores students' perception of teachers' use of ICT. This data was also used to inform the interventions for this study. To gather information, two research instruments were used: a questionnaire and group interviews. The results from the questionnaire (Table 7) suggest that most students (82%) perceive that teachers frequently use technology in the classroom. However, the percentage of students who stated that teachers use the VLE's tool for learning and teaching decreases to 60%, and this dropped ever further (to 50%) when pupils were surveyed about teachers using the VLE for tasks other than setting homework or uploading files, suggesting that, although students see that teachers use ICT, such use does not reflect employment of the VLE in particular.

Question	*N*	Strongly Agree	Agree	Disagree	Strongly Disagree
1. My teachers often use technology in the classroom.	109	25(23%)	64(59%)	13(12%)	7(6%)
2. My teachers often use the VLE as a tool for teaching and learning.	109	11(10%)	49(45%)	40(37%)	9(8%)
***4. My teachers often use tools from the VLE other than to set homework or to upload files.**	109	8(7%)	42(39%)	37(34%)	22(20%)

*Q3 was not included, as it was part of the survey only as a suggestion from my line manager and is not directly relevant to this work

Table 7 Students' survey on teachers' use of technology and the VLE

The interviews may provide a clue as to why these answers were given, as students recognise that the use of technology among teachers is inconsistent, owing to a lack of understanding of ICT. Students (coinciding with teachers' perceptions) stated that they help teachers to use certain technological tools. And some students (such as Roger) felt that the lack of understanding of technology led teachers to disengage with ICT, thus affecting, according to Lyndon & Hale (2014), any further engagement with, or implementation of, new methods:

> *Some teachers just don't like it or do not see the point of it... So, they just stick to the usual methods...*

However, students (reflecting teachers' perceptions) stated that the latter do not appear to have the equipment necessary to fully implement technological teaching in the classroom, thus affecting teachers' commitment, and echoing the findings of Weller (2007). Additionally, for some students, teachers' TK is central to the adequate use of ICT. In this respect Carlton believes that:

> *Some [teachers] don't know how to use it… and for some subjects… using technology... doesn't help at all… But when it's used properly* [and] *it's being planned properly it is effective.*

Thus, when teachers' TK lacks awareness of the affordances or is not linked to adequate pedagogy, it may be perceived as an impediment. However, students still see that technologies have the potential to benefit teachers and students alike, as Roger states:

> *It's… easier for the teachers… because they don't have to... write out everything on the board. They can just do a PowerPoint, type it on it, and it can be easier for students [to access].*

Although the literature suggests that this is not the best use of the VLE (Lyndon & Hale, 2014; Gonzalez, 2010; Blass & Davis, 2003), students appear to value the use of this platform as a repository for delivering information. It could be that they do not know any other affordances of the VLE or that it is the way in which students interact with this platform more often. From this perspective, some pupils believe that, in accordance with Lyndon & Hale (2014), it is important to maintain up-to-date resources.

Overall, students recognise the importance of using technological means to facilitate learning, revision and flexibility, as technology is already a part of their lives, echoing Apsden & Helm's (2004) claims. For example, Gertrude posits:

> *It's important that we have technology, because of the amount it's used later in life.*

Some students, however, found that using the VLE may become inconvenient when tasks online resemble those offline, matching Lyndon & Hale's (2014) findings. For example, Carlton suggested:

> *If I'm set… homework on the VLE, I… find that really inconvenient… If I could do it on paper… I just feel.... they could just get a question and I could write it out…*

Furthermore, although some students perceive that there should be more use of ICT on different fronts, those students who were about to sit, or had sat, exams disagreed. This was because of the way they learned or the way in which they were going to be

assessed, which matches Bennet et al.'s (2008) claims, according to which younger students do not have distinctive learning preferences influenced by ICT. For instance, the following fragment of a conversation reflects the differing views:

> *Roger: Instead of… handwriting everything, you could just use a laptop… to type up…*
>
> *Ariana: Not really…* [in] *some lessons it's easier to just make handwritten notes…*
>
> *Carlton: I feel like it's easier to learn when you're actually writing stuff down…*
>
> *Ariana: …if you write* [in the exam]*, you need to practise on keeping to the timings…*

During the second interview, however, students expressed that teachers are using the VLE more to set homework, and in some subjects, such as ICT, are doing their assessments using the platform. They welcomed this development and remarked on the value of having the opportunity to know their scores when they finished their tests, supporting Ronnie's (2011) claims. They recognised that there has been good progress in most subjects, meaning that they would not consider a subject better or worse when using the VLE.

Largely, pupils hold a positive view of teachers' use of ICT. However, this perception changes when students are asked about teachers' use of the VLE and its affordances specifically. This suggests that initial use of the VLE (by teachers) has been inconsistent. In this connection, pupils see teachers' lack of understanding of ICT as a drawback to implementing tools such as the VLE. However, students also recognised that the lack of equipment had a role to play in the problems that the VLE has faced. Moreover, although students recognise the potential of technological tools, they also feel that

using technology alone does not have a value per se, those tasks that resemble tasks offline being viewed negatively. On the contrary, proper use and focus of these tools which effectively aid learning is viewed as highly desirable.

Students value the use of the VLE as a repository which may mean that they do not know any other affordances of the platform, or that their experience of it has permeated their view on how this technology can be employed. However, after implementation, students valued the way in which some subjects were using affordances that they did not know before. For instance, self-marking quizzes, which allowed them to know their scores as soon as they finished their assessment, showing how the use of other tools from the VLE is promising.

6.3. *Interaction of different subjects with educational technology such as the VLE to support students' learning*

> *"In science or… business they have a lot of… revision* [materials] *uploaded. So, when I'm at home… revising, it's easier for me to look at…a prepared revision…"*
> *Ariana*

This pupil's opinion suggests that subjects such as business or science are very active users of the VLE. But, as presented above, it is used as a repository. This, again, corresponded to the teachers' views that, this is evident, for example, in M's comments:

> *We all use…* [and] *put resources on the VLE. [We] are setting tasks so that students can upload their work. The only thing that I would say with that is... not all students do. And… we don't always have computers available in science.*

This suggests that such use does not result in student engagement. Additionally, a lack of hardware to support the tasks prepared by teachers, renders use of the platform difficult and limited. However, after the first training session with the Science Department, when I discovered that most teachers in this subject-area had already completed the task list planned for the whole process, demonstrating that teachers from this department were well disposed towards the use of ICT, confirming Cox & Webb's (2004) claims. I wrote in my diary:

> *In science, as most of them had already completed the task list prepared for the whole three stages of the intervention, they decided that, instead of completing extra tasks, they would discuss a way of implementing such tools*
>
> (Researcher Diary March week 4)

Science generally received training opportunities well and created task lists which were completed by students. They were pleased with the way in which they could target students' progress, as well as verifying students work.

Humanities was another subject in which teachers appeared well disposed towards training on using the VLE; this was in direct contrast to the ideas presented by Cox & Webb (2004), which suggested that humanities had a low engagement with ICT. Additionally, this department also seemed to have a greater awareness of the limitations of the platform for their own subject-area, as seen in G's ideas:

> *We're quite good with our technological interactions…* [but]*for topics like history… that are… essay-based, it's a little trickier to use something like self-marking… because sometimes we fall into the trap… where you have to have an explicit right or wrong answer.*

After the training took place, humanities soon started working to implement those tools in which they had been trained, and I was asked by the HoD to work with them

during the gain time to put things in place. This impact was also recognised in the second interviews. As seen in G's comments:

> *I think we are… beginning to use [the VLE] much more effectively than we have done in the past.*

In MFL, both teachers interviewed recognised the role of one of the members of their department (E) in using technology. This subject was particularly focused on the use of their own platforms which were tailored to allow students to learn languages. This, in their eyes, seemed to generate conflicts with the use of the VLE, as it appeared to be assumed that both the VLE and their own platforms did the same job. N stated:

> *It's used… by 'E'. I don't think it's used by the other three… because we've got things like… Activelearn...*

However, after the training they appear to consider that the VLE would allow them to overcome some beliefs and to recognise the value of the platform. They also felt that the training had had some positive effect on their practice. For example, D states:

> *It's helped me to be more confident to set a homework… that's a little bit more varied… I wouldn't have bothered otherwise. I would have just set traditional homework…*

A similar story, regarding the use of multiple platforms, was found in Maths. They have the use of tailored websites such as mymaths.com. Thus, teachers tend to consider that the VLE has limited use within this subject. As R suggested:

> *We will use the maths-specific technology that we have to hand… It does mean that there are facilities on the VLE that we will never use. But don't think that that puts it into conflict with [the VLE]… I've used the VLE as a repository… as a backup.*

Thus, as expressed by R, teachers believe that using different technological platforms does not lead to a conflict in maths, but it certainly tends to limit the use of some of the affordances offered by the VLE. This use as a repository appear to be the case in other departments such as English, fitting Cox & Webb's (2004) findings. But they also recognised the value added that technology brings to engage students. MF said:

> *With English it's slightly different. But… I use it… because especially… with older kids… that is how to engage them in lessons.*

However, the workload that English teachers face can be recognised as a serious issue. Particularly when this department did not receive any department-based training owing to the impossibility of booking a session.

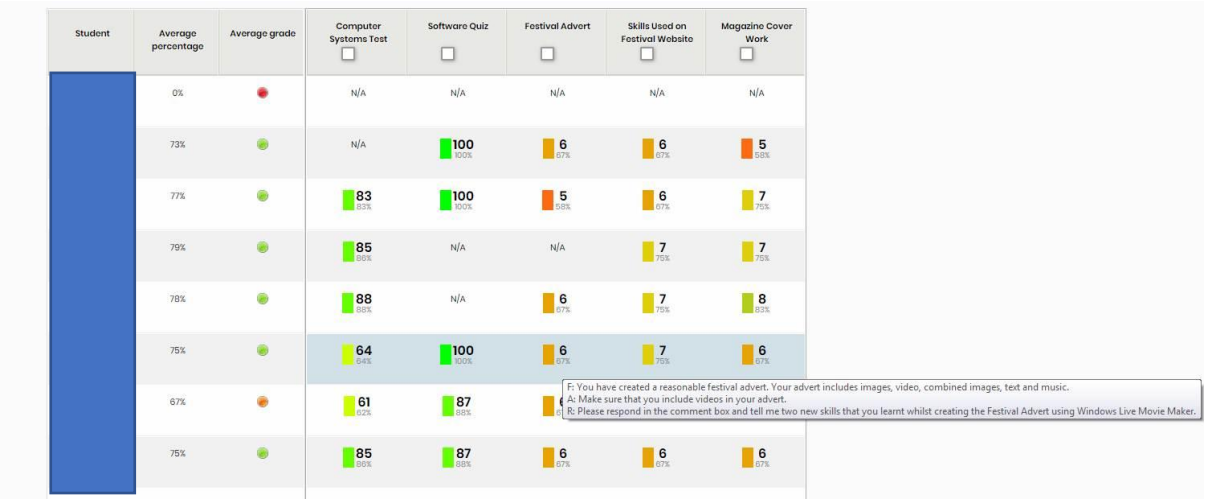


Figure 7

ICT is, without doubt, the flagship department in the use of technology. They were one of the first departments to implement the use of the tools from the VLE in their teaching (for example: Markbooks, feedback, quizzes etc.) (Figure 7). Here the role of the collaborator was key, as she had clear aims after attending the training (a similar situation was present in Arts). One of my collaborators stated towards the end of the process:

> *We have used the VLE for creating our end-of-year assessment… Tests are self-marking, automatically inform students what they have achieved, and they can also see which questions they got wrong. This gives them the chance to reflect on what the correct answer would have been… We hardly ever print out students' work which… saves on costs. We have [also] used task lists for our Year 10 students as a revision aid and they really enjoyed using it.*

RE, my own subject, also uses the VLE mainly as a repository for GCSE and A-levels. Teachers here were quickly engaged with the tools presented, but the implementation was inconsistent. This could be due to the delays in training, as when I was back in my subject for departmental meetings there was other business that took priority. However, many members used affordances such as quizzes whilst others were very consistent in setting homework. It is worth mentioning that there is still a fear of using ICT where students are at an advantage, as LM states:

> *I… wouldn't be happy with too much sophisticated technology. I want something that I'm comfortable using, because the children will soon pick up if you don't know what you're doing.*

Overall, and in accordance with Howard, et al.(2015), pedagogical and subject-specific beliefs may affect the way in which different departments interact with the VLE, making their involvement 'patchy'. Nonetheless, departments such as computing, humanities and science performed well, implementing some of the tools of the VLE during the period of training and finishing the task list earlier than expected. Other departments had an uneven development, meaning that some teachers performed very well, while others were lagging behind. And some subject-areas such as English use the VLE and recognise the value of technology, but the amount of work they face meant that the training for them was not delivered. It is also worth mentioning that subject-based beliefs and the use of other platforms also affect the way in which teachers from different subjects interact with the VLE.

6.4. Effectiveness of a department-based whole-school intervention approach to support the development of teachers' TPK

Despite the challenges the department-based strategy brought (Section 5.1.2), in general, teachers found this strategy highly valuable, as it allowed them to engage with the tools and train more easily as per the literature review (Broadley & Trinidad, 2008). In this connection, LM considered that for further training she would like:

> *Having more department-based... because then that enables you to come around one to one. You are not dealing with so many people.*

Another point is that working in departments provided opportunities for targeting specific questions tailored to the small groups, as well as to particular subjects. This, according to M, was a positive development:

> *We had quite a few questions as we were going through it, which… if we had all the staff together, you wouldn't have been able to address.*

This idea was reiterated by multiple interviewees such as LM, referring specifically to the need to be in departments:

> *That's a much better idea, because, for example, Maths probably… needs… different tasks… compared with RE…*

A similar view, pointing to the differences that departments face when using the VLE, was shared by G, who expressed:

> *We don't use it… as other departments… like science or mathematics... but we're trying to make… technology suit our subjects and increasingly more so*

Using department-based approaches was also recognised to be more beneficial than whole-staff strategies, as it allowed a more effective use of the VLE, as stated by G:

> *We've approached it much more topic-based, whereas before it was very… generalised within the school… we are… beginning to use it much more effectively than we have done in the past.*

This was supported by other teachers who argued that more time for training within departments was desirable.

In all the implementation the role of the staff in leadership, and their attitude towards technology, also impacted the way implementation took place. Teachers from similar departments seemed to mirror those attitudes displayed by their HoD or other people in leadership positions. This could be either a potential force for development or an obstacle to developing any technological implementation.

As previously suggested, the department-based approach seemed to be regarded as positive by teachers. However, some of them felt that a mixture of department-based and whole-school approaches would have been beneficial. They found that, whilst departmental training had its added value by allowing them to introduce and discuss elements more relevant to their department, a whole-school focus allowed them to share good practice from other departments.

Besides this, using the VLE to train teachers was also highlighted as an aspect which added flexibility and enabled them to work at their own pace, in line with the suggestions from Bates (2005), Broadly & Trinidad (2008) and Paulsen (2008). This also indicates that using the framework successfully supported the implementation. For example, G said:

> *It was really nice using the VLE as a way to train us… because it made us familiar with… different things you can use… and… I'd like to do more…*

Additionally, despite the training provided and having a greater understanding of the platform, some teachers still expressed resistance to using ICT. For example, N said:

> *It's not something I'm interested in… that's why I struggle with it... I've never been convinced that it's more effective than just me standing there teaching.*

For some of them, such beliefs, combined with their workload and the lack of time available, posed further problems. This finding corresponds to the claims made by Cox & Webb (2004), according to which beliefs play a key role in the implementation of technological tools at school . On this, D expressed:

> *I could have been of a slightly fixed mindset when it comes to this… Is it fear of it? I think so... It goes back to the time constraints… and things get pushed to the bottom when it's illogical because that's my shortcut. So, it's kind of stupid.*

Moreover, not all teachers (or departments) progressed in the same way; for instance, whereas some teachers finished the whole task list before planned, others failed to complete it. Such disparity in progress made, and teachers' (and subjects') beliefs impacted teachers' attitude towards the sessions. Although we have a good rapport,

it was noticeable that some teachers were completing the tasks set out of respect and camaraderie, rather than interest. For instance, I recorded in my researcher diary:

> *In maths the training did not run as smoothly. Some members of this department were somewhat reluctant to complete the tasks provided. One member, particularly, remarked on the uselessness of the training owing to the department having other platforms that would do the same work*
>
> (Researcher Diary March week 4)

This story, however, had a twist, as this teacher decided to use the VLE as a hub for the other platforms already present in maths (Appendix 12). After this, I recorded in my diary:

> *Certainly, focusing on the affordances of the VLE has paid off. X has used the VLE to do some revision for her year 10s*
>
> (Researcher Diary May week 3)

This was not an isolated case, and it indicates that, although implementing ICT may bring challenges, those are not necessarily negative, as suggested by Broadley & Trinidad (2008).

Additionally, some teachers engaged with particular tools offered by the platform, which were deemed useful for delivering their courses. For example, X showed early interest in forums and tried to implement them with students. I recorded in my diary:

> *X spoke to me about how she tried to implement forums on the VLE. She described how, while with sixth form students, she contacted the VLE support using the chat. They helped her to set it all up and all the students worked with their teacher to implement this tool.*
>
> (Researcher Diary February week 2)

However, there were some issues. For example, despite teachers' and students' willingness to engage with forums, the affordances of the VLE appeared to inhibit the use of such tools, and they may require further development, especially when students are accustomed to services such as WhatsApp which are highly intuitive.

On the whole, the training appears to have been well received by teachers, some of them such as L recognising that:

> *There's been a… big drive on using VLE… I find it particularly easy for key stage 5 to check their assignments. But... it's much easier for me to transmit the work home and check it as well.*

This drive was possibly noticed because of the interventions conducted by the collaborators or myself. The opinion about morning briefings was generally positive and there was a recognition of the usefulness of the training provided. As R expressed:

> *That was excellent, because that's all that a person can cope with... in the morning…*

Generally speaking, after the first two sessions (when the second interviews were conducted) most teachers recognised that they now knew some other affordances of the VLE that they did not know before, reflecting that some progress had been made and that also helped them to reduce their workload, as in the case of G:

> *I was… reluctant to use… the VLE for handing in pieces of homework… but seeing it in practice… I feel more confident in my ability to use it… I'm finding my workload is much more bearable now because I can include things like self-marking tasks…*

A further element is the mixed perception of teachers when asked if they had acquired any new TK as a result of training. There was an array of responses varying *from* those whose knowledge was already solid both in the affordances of the VLE and in their use of technology, meaning that there was nothing new to learn, *to* those who felt that some learning had been done, but it had not been embedded. For example, R expressed:

> *I don't know that I've actually done anything different since the training... I think it's served as a reminder…*

In contrast N suggested:

> *As soon as your training finished, I felt that I knew what to do [but] I haven't gone back to it. I need to be refreshed.*

As time is a very limited asset when it comes to teaching, another important point brought to the interviews is how extra time for absorbing and starting using the tools is important. This matches what happened in humanities, where they asked for support during gain time to aid implementation of the VLE. M's ideas reflect this:

> *I need a bit of time to absorb it and use it more. So, that would be quite a good thing to do during gain time…. And so, something like the VLE, the tasks that you showed us, the quizzes and things like that… [might be shared within] the department to prepare ready for next year. Because it's time consuming.*

After the third training was conducted (Table 3), some conversations with teachers took place. The conversations provided three main elements for reflection. *Firstly*, there was a clear message that was perceived as useful by teachers. For example, Y stated:

> *The key point… was the need for teachers to develop expertise in the technology that they use which is relevant to their classroom practice…*

Secondly, some teachers felt that the issue of reducing workload using the VLE was worth pursuing. On this, O believes that it is important:

> *identifying what…teachers want in terms of reduced workload, how the VLE can achieve that…*

However, many teachers felt that it was too broad. Again, the approach whereby all teachers in a room are presented with a new initiative appeared to be ineffectual. The following opinions raised specific problems regarding this third training session:

> *it was probably too broad in scope, and something much shorter with a specialist subject focus for each department would have had a greater impact… I wasn't sure what I was taking away from it.*

Additionally, this study produced further suggestions based on teachers' perceptions. *First,* having a person who can dedicate the time for training, implementation and clarifying teachers' doubts. What makes this suggestion particularly significant is that it comes from N, one of the teachers who was more reluctant to engage with the VLE:

> *You need more time to be able to do this because when you're on a full teaching timetable, you don't really want to give up your preparation time by loads of people coming to see you and saying can you teach us how to do this?*

Second, some teachers suggested that continuous training and reinforcement thereof was needed. For example, D said:

> *I know, sounds a little bit needy for a teacher to say that, but just that constant topping up on that small scale. So, coming into meetings more.*

Third: student engagement. All the interviewees but one highlighted the importance of getting the students on board, otherwise the VLE would not decrease the workload, but increase it. This issue with engagement also shows a greater need to work on the ethos and contract of mutual support between teachers and students (Mayes & Fowler, 1999) to create a collaborative environment.

Conclusions

This study, examining a whole-school intervention supporting teachers' Technological, Pedagogical and Content Knowledge concerning the VLE, has allowed me to draw a number of worthwhile conclusions. *Firstly*, the *department-based strategy* provides an effective way of implementing technological tools that is valued by teachers, but it must be flexible enough to adapt to different teachers' progress. However, training in different departments tends to be variable and dependent not only on individual ability but also on the time constraints and willingness of those in leadership positions. *Secondly*, teachers seemed to feel comfortable with their CK and PK, although their confidence about using TK varied not only from teacher to teacher, but also from department to department. This indicates that TK changes in every subject, particularly when the technological affordances are considered. Consequently, whilst *TPACK* offers a wider framework for the use of ICT in education, *it does not tackle all issues arising from training teachers on, and with, VLEs*. *Thirdly*, the use of my *project framework* (Section 3.3) offers a more viable way of training teachers by providing a deeper knowledge of the affordances of different digital media, facilitating their adaptation and their combination with those knowledges present in TPACK, supporting instructors and teachers alike. *Fourthly*, *using the VLE provides a context which enhances the training of teachers*, offering both the required flexibility and the opportunity for familiarisation with the platform. This affords teachers the experience and breadth of use which, in time, appear to modify conflicting beliefs. Nonetheless, despite the interest expressed by some teachers in using some VLE tools, the lack of development of particular affordances may make it difficult to fully implement all of them or to generate further engagement. Whilst not all teachers completed the task list prepared, all of them appeared, in general, to value the training received. This

included N, who progressed from considering himself a 'dinosaur' to developing a more positive attitude towards the VLE, even making further suggestions for its implementation. However, my research also revealed that teachers' beliefs can still impact implementation of the VLE, as they may generate resistance to the technology, driving teachers to dismiss the added value imparted by ICT.

My research suggests that the department-based strategy, in addition to being well-regarded by teachers, may provide an ideal way forward for implementing educational technology as a whole-school enterprise, as it facilitates the targeting of issues relevant to specific subjects, an aspect viewed by some as fundamental when training teachers (Goodwyn & Findlay, 2003). This finding supports Cox and Webb's (2004) claim that ICT is more effective when teachers know how to use it in their own areas. Furthermore, notwithstanding the principle that 'small groups work best', a department-based approach promotes subject-based discussions which contextualise technology in teachers' subjects, making training in ICT relevant to their practice. Training teachers in this way helps to identify and challenge those subject beliefs (Howard, et al., 2015) regarded as problematic by some scholars (Nikolopoulou & Gialamas, 2016; Jimoyiannis & Komis, 2007). Moreover, it may be argued that, by adopting this strategy, teachers' personal beliefs concerning technology (John & Wheeler, 2008; Lyndon & Hale, 2014; O'Mahony, 2003; Becta, 2004; Nikolopoulou & Gialamas, 2016; Thorsteinsson, 2013) are also challenged, as departmental contexts help teachers to acquire experience and broaden their use of the VLE (Helsper & Eynon, 2009) with a particular subject focus by instigating interaction with their peers. Such a dynamic also appears to encourage the development of what Underwood (2007) and Bandura (1997) termed 'teachers' self-efficacy', as teachers

learn from their peers about how to apply specific tools in ways they had not previously contemplated, although the results are somewhat inconclusive and further research in this area is necessary.

As far as the *limitations of TPACK* are concerned, the findings of this study support Voogt, et al.'s (2012) claim that TPACK is specific to the subject in which it is applied. Indeed, using TPACK provides a wider framework and context for working with technology, where TK, PK and CK are combined (Koehler, et al., 2017; Koelher & Mishra, 2009). They also appear to imply that, merely by combining TK with PCK, TK would be adapted to specific subjects and that this process would be the same across different subject-areas. However, the way in which progress differs from teacher to teacher, and more importantly, from department to department, as well as the way in which the understanding of TK varies, makes TK's adaptation a much more complex process. In this regard, and in conformity with the literature, the present research suggests that TPACK falls short of fully addressing what is needed for the implementation of technological tools such as VLEs as a whole-school project, as it does not give teachers a full understanding of how to use ICT in their own areas, an aspect that Cox & Webb consider fundamental (2004). For example, the use of a video in MFL is different from that in science. In the latter, the main point of interest may be the steps involved in a scientific experiment, with little consideration given to the way in which language works. In MFL, on the other hand, it is the language that takes centre stage. Thus, the affordances that multimedia tools have must be taken into account to suit the specificity of the educational context (Vygotsky, 1978), where content and tools are deliberately selected (Bennet & Matont, 2010), but TPACK does not provide teachers with an understanding of such differences. Therefore, whilst it is

true that TPACK aids and supports the dialogue between different types of knowledge present in the educational context, it fails to recognise the intentionality and affordances that specific media may bring into the classroom and how this would affect learning, thus echoing Cox & Webb's (2004) claims.

With regard to the *project framework* (section 3.3), data gathered in this research suggests that this has proved successful in helping to drive implementation and modifying teachers' attitudes. Despite the fact that CF is yet to be commonplace in educational software for secondary schools (Cox & Webb, 2004), and that any dialogue within the departments occurred primarily in face-to-face situations, CF still encourages instructor-teacher dialogue (Neo, et al., 2013), which is also enhanced by working within departments. This is because Laurillard's (2002) CF complements TPACK by providing the instructor with the scaffolding for working with ICT (Cox & Webb, 2004) and the understanding that each kind of media brings particular functionalities (or affordances) (Laurillard, 2002) to the teaching-and-learning process. Thus, the project framework arguably facilitates the exchange of knowledge (Holmberg, 2016) and adaptation of the VLE to different departments. This means that the framework would prove valuable for tasks involving adaptation of the VLE to the various subjects (bearing in mind the changing nature of teachers' beliefs, skills and willingness to work with ICT). Consequently, it may be argued that the project framework is able to combine such beliefs, the range of skills present in teachers and the ever-changing nature of digital technologies (Koehler & Mishra, 2008).

On the *use of the VLE for training teachers*, my study findings suggest that it supported departmental discussions, allowing teachers to find the best way of using the platform

to support their pedagogical practice, in accordance with Neo, et al.(2013). The findings also indicate that using the VLE to implement the framework, in accordance with Bates (2005) and Broadley & Trinidad (2008), allowed teachers (in the role of students) to personalise their learning and afforded the flexibility that Paulsen (2008) considered important. It appears that the use of the VLE to train teachers also supports the framework by offering an environment that gives teachers the space required for increasing their experience and breadth of use and allowing the instructor to assume shifting roles to support teachers at different levels (Broadley & Trinidad, 2008), while facilitating dialogue in a blended learning context. Furthermore, this research shows that, in order to ensure successful implementation of the VLE, the use of such a platform fosters the creation of a more collaborative environment (Broadley & Trinidad, 2008) where there is a production of knowledge (Nolan, et al., 2012), as teachers are exposed to the affordances of the VLE. It also suggests that the traditional ways of training teachers, where they are shown how to do things through a presentation, may not only be ineffectual, but could also promote further beliefs incompatible with the implementation of ICT. In this connection, it is hoped that this study may open the way for a wider discussion and for the discovery of more effective methods of training teachers in the use of ICT (particularly VLEs) in secondary schools, which has arguably become an integral part of the educational context. Importantly, the value of this study lies not in its assessment of the usefulness of the individual components used for training teachers (i.e. the VLE, the project framework and the department-based strategy), but rather in its evaluation of how these components interact. Such interaction aids the selection of media based on their affordances in order to target specific learning needs and increase teachers' engagement with the training. This can challenge disparate beliefs, facilitate adaptation to different departments, increase the relevance of the

training for teachers and give the instructor the ability to adapt generic training to suit a wide variety of subjects, in response to the so-called changeable nature of ICT (Koehler & Mishra, 2008) and the uniqueness of the educational context (Vygotsky, 1978). However, little academic research is available on training teachers on the VLE in secondary schools (existing studies concern only students' use of the VLE), which makes it difficult to relate the present study to other research in the field.

Limitations

Notwithstanding the claims made in this study, students' engagement (Blass & Davis, 2003) remains problematic, owing perhaps to the fact that training teachers does not necessarily impact students' interaction with the VLE, or that many subjects still employ the VLE purely as a means of delivering information, which suggests that its use would not necessarily engage students (Blass & Davis, 2003). Additionally, in conformity with Ping Lim & Sing Chai's (2008) assertions, this use of the VLE indicates that compatibility of teachers' beliefs with constructivism would not be enough to overturn traditionalist use of ICT. However, as argued above, my study findings appear to show that the combination of the study framework, the department-based strategy and the use of the VLE to train teachers could provide a way forward for tackling these issues, helping to bridge the gap between a range of disparate beliefs. Yet these beliefs (both participants' and collaborators') continue to represent the most challenging aspect of technological implementation, and appear to be reinforced when compounded by other constraints, such as costs and lack of resources. Consequently, additional research in this area is called for.

In completing this study I have also faced other limitations, ranging from those arising from the interpretation and collection of data (Sections 5.2 and 5.5) to issues such as the lack of appropriate resources for conducting interventions or for helping teachers to interact with ICT (Section 6.1). Additionally, the dynamic nature of the school environment meant that, contrary to plan, I had to conduct the second interview with teachers before all the interventions had taken place, meaning that teachers may not have had a full picture of the interventions at the time of their interviews. Although the findings of this project exhibit some methodological weaknesses, they could offer valuable guidance for those planning to conduct whole-school implementations of ICT, involving the training of teachers using VLEs as a way of delivering such training.

Implications

My research has impacted my practice in multiple ways. Firstly, as a teacher, it has offered me a different perspective on the use of ICT and the advantages it may bring to the classroom. Secondly, as VLE Coordinator, it has allowed me to discover the diversity of teachers' views and increased my awareness of the need for training teachers, and this, hopefully, will help me to develop the VLE. This work has also led me to question some widely-held views about the role of the researcher within the school system, whilst reaffirming the notion of the value added that practitioner research brings to the school environment. Accordingly, the findings of this research will be shared with the SLT at my current school. In other fields, this project has empowered me to think more critically about different methods and tools employed

in education, highlighting the importance of training teachers in a meaningful way that targets their pedagogical practice. On a more personal level, it has suggested some ideas for possible future research towards a PhD, in which I would hope to look more closely at certain ethical aspects of technological implementation and data gathering, having been made increasingly aware of various ethical risks posed by the use of ICT in the field of education.

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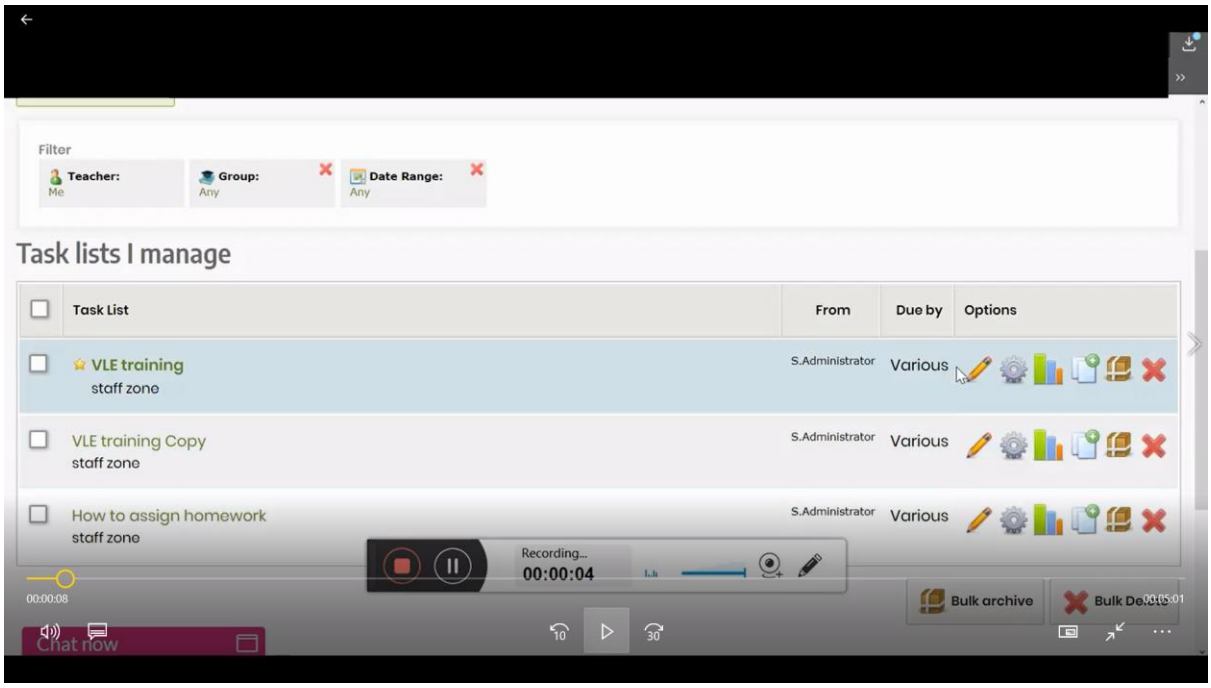
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Appendix 1: List of abbreviations

AR	Augmented Reality
Becta	British Educational Communication and Technology Agency
BERA	British Educational Research Association
CK	Content Knowledge
CPD	Continuing Professional Development
CUREC	Central University Research Ethics Committee
DfES	Department for Education and Skills (reference)
HE	Higher Education
HoD	Head(s) of Department
HSF	Oxford Backup System
ICT	Information and Communication Technologies
LMS:	Learning Management System
MFL	Modern Foreign Languages
PCK	Pedagogical Content Knowledge
PK	Pedagogical Knowledge
Q	Question(s)
RQ	Research Questions
SLT	Senior Leadership Team
TCK	Technological Content Knowledge
TK	Technological Knowledge
TLA	Teaching, Learning and Assessment
TPACK	Technological Pedagogical and Content Knowledge
TPK	Technological Pedagogical Knowledge
VLE:	Virtual Learning Environment

Appendix 2: video on the task list

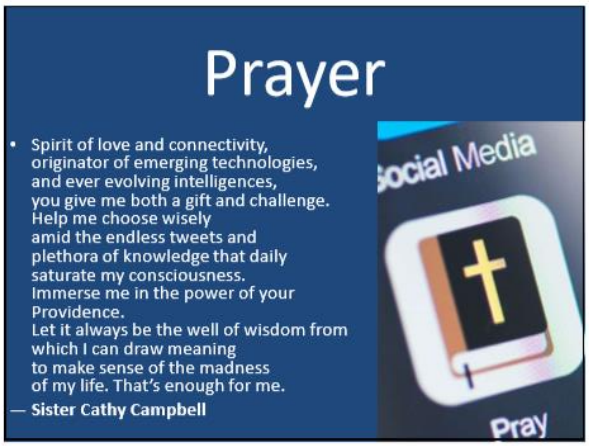
Please refer to video attached.



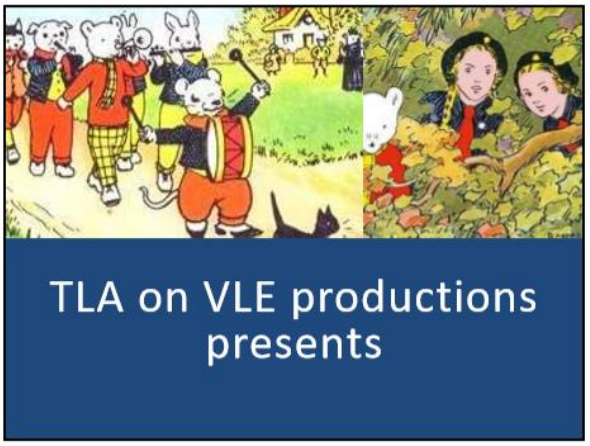
Appendix 3: Example of Two stars and a wish delivered by a Collaborator



1



2



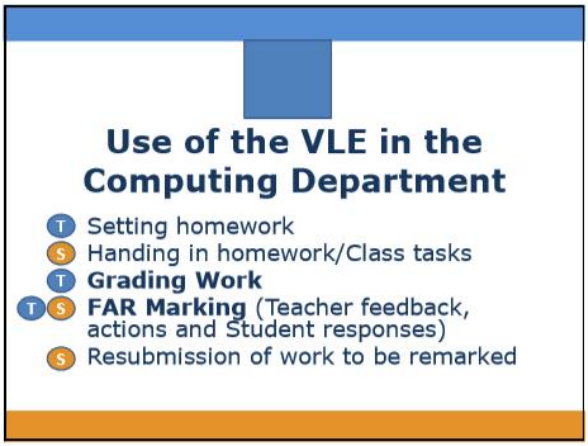
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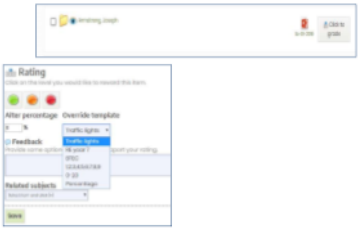
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6

Grading work on the VLE

- S Work will be submitted for marking on the VLE
- T Assess work
- T Grade given



7



Star 2

FAR Marking on the VLE

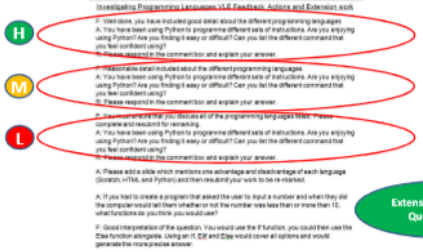
8

FAR Marking

- T **Feedback** given about the work submitted.
- T **Action** set (usually in the form of a question to further develop understanding or the students are encouraged to add other details to work and resubmit).
- S In class students are given the opportunity to read the feedback and **Respond** accordingly.

9

Comment Banks



Extensions/Further Questioning

10

Advantages of using the VLE for FAR Marking

- Comment banks are generated according to the task and can be reused for other groups (saving time ☺)
- No books to carry home, just laptop!
- Reduces printing/reprinting work
- Students familiarise themselves with the process and enjoy the chance to improve grades and discuss their work with their teacher.
- Useful to show at Parents Evening

11



A Wish

A task for you

12


Your Task
Try to organise tasks that can be marked in this way.
Discuss in your subjects how could you implement these ideas

13


Notices
NOTICES

14

Appendix 4: CUREC

ED-CIA-19-022

Dear

TITLE:
Supporting teachers' development of Technological Pedagogical Content Knowledge: a whole school intervention

The above application has been considered on behalf of the Departmental Research Ethics Committee (DREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to DREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly, approval has been granted.

If your research involves participants whose ability to give free and informed consent is in question (this includes those under 18 and vulnerable adults), then it is advisable to read the following NSPCC professional reporting requirements for cases of suspected abuse

http://www.nspcc.org.uk/globalassets/documents/information-service/factsheet-child-abuse-reporting-requirements-professionals.pdf

Should there be any subsequent changes to the project which raise ethical issues not covered in the original application you should submit details to research.office@education.ox.ac.uk for consideration.

Good luck with your research study.

Best wishes
Nicola

Dr Nicola Warren-Lee
Geography PGCE Curriculum Tutor

Appendix 5: Sample of letter to the Head Teacher

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: +44(0)1865 274024 Fax: +44(0)1865 274027
general.enquiries@education.ox.ac.uk
www.education.ox.ac.uk

Director Professor Jo-Anne Baird

Head Teacher

School

Address

10th November 2018

Dear Mr _____,

I am writing to enquire about the possibility of conducting research in school this academic year. As you know, I am studying for the Master's in Learning and Teaching at Oxford University, supervised by Dr _____. In my final research project '*Supporting teachers' development of Technological Pedagogical Content Knowledge: a whole school intervention'* I will explore the impact that supporting teachers' development of Technological Pedagogical Content Knowledge (TPCK), in different curriculum subjects and using tools such as the VLE, may affect educators' practice.

The research will involve a group of teachers from different subject areas at school, and a small group of teachers who will collaborate with the research project as they are part of the TLA group formed by the Learning and Teaching Head Assistant. This group has agreed to collaborate in implementing three stages of the intervention to support teachers based on the three assumptions by Mayes and de Freitas regarding electronic learning:

Associationist/empiricist: understands knowledge as a gathering of skills and associations (content/skill centred). The intervention generated here will be centred around training on the use of VLE tools which allow teachers to develop students' content knowledge and skills, such as questionnaires.

Cognitive: where knowledge is constructed over and above the thought and language processes, using memory and the development of concepts (curriculum centred), in which a more exploratory use of technology is encouraged. For example, the use of webquests.

Situative: here the subject and his/her knowledge are exposed to the influence of his/her sociocultural environment (learner-centred). For this an initial form of Laurillard's conversational framework will be involved.

To collect data, a whole school anonymised survey will be conducted in which students will be asked about the method and frequency of teachers' use of technology in the classroom. Prior to the interventions, teachers will also be interviewed and surveyed about their perceptions on the use of technology at school. Two more interviews will be conducted once one or two of the three aforementioned interventions have taken place, and at the end when all the training for teachers has been delivered. A final survey for students and teachers will be conducted in order to capture any changes in perceptions that students and teachers may have once the interventions are completed.

By participating in the research, the school would be contributing to a project that will deepen our understanding of how supporting teachers' TPCK in different subjects may impact their practice, which may ultimately affect students' learning, and so contribute towards developing ways of improving TPCK in teachers' working with technology for learning, such as Virtual Learning Environments, in the future.

I hope to conduct this research between November 2018 and June 2019. I would survey students in two different stages, interview and audio-record teachers engaged in the project, use materials generated by teachers during the implementation of the project and use minutes of the meetings with the TLA group, which would be the same group of collaborators.

Oxford University has strict ethical procedures on conducting ethical research, consistent with current British Educational Research Association guidelines. The University also recognises, however, that my study is a piece of practitioner research, and that schools already operate to the highest ethical standards. Therefore, only <u>your</u> formal consent as Head Teacher is necessary, and not that of individual parents or staff. However, throughout the research, students and other teachers will be able to refuse to participate in any research activities at any time.

All participants, including students, teachers and the school, would be anonymised in all research reports. The data collected would be treated in strictest confidence and would be available only to my supervisor Dr _____ (xxxxxxxxx@education.ox.ac.uk) and myself, and used purely for academic purposes. It will be kept for as long as it has academic value.

If you are happy for me to proceed with this study, please confirm this using the attached reply form. If you have any concerns or need more information about what is involved, please contact me or my supervisor. Furthermore, if you have any questions about the ethical process at any time, please contact the Chair of the Department's Research Ethics Committee at: research.office@education.ox.ac.uk

Thanking you for your kind attention and looking forward to hearing from you,

Kind regards,

CONSENT AND COLLABORATION

The research project will include a range of teachers based on their willingness or resistance to use the Virtual Learning Environment (VLE), on their instrumental and pedagogical knowledge applied when working with technology, and on their record of utilisation of the VLE.

If you are interested in the research or have been asked to take part on it, you need to be aware that your participation is entirely optional and that **you may withdraw collaboration at any stage if you so wish.** You **will be guaranteed anonymity at all times,** and when interviewed you will be given pseudonyms.

A small group of researchers will be formed (TLA group) in which five different teachers will collaborate in implementing three stages of the intervention to support teachers based on the three assumptions by Mayes and de Freitas regarding electronic learning:

UNIVERSITY OF OXFORD

ADDRESS

Department of Education
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15 Norham Gardens
Oxford, OX2 6PY

CONTACT US

Department of Education
| +44 (0) 1865 274024 |

MSC IN LEARNING AND TEACHING

RESEARCH PROJECT

SUPPORTING TEACHERS' DEVELOPMENT OF TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE: A WHOLE SCHOOL INTERVENTION

The present study is a small-scale practitioner research project which is intended to explore the impact of supporting teachers' development of Technological Pedagogical Content Knowledge (TPCK).

Appendix 6: Sample of brochure distributed to teachers.

STAGES OF THE INTERVENTION



ASSOCIATIONIST/EMPIRICIST

This first stage/intervention understands knowledge as a gathering of skills and associations (content/skill centred). The intervention generated here will be centred around training on the use of VLE tools which allow teachers to develop students' content knowledge and skills, such as questionnaires.



COGNITIVE

In this second stage/intervention knowledge is constructed over and above the thought and language processes, using memory and the development of concepts (curriculum centred), in which a more exploratory use of technology is encouraged. For example, the use of webquests.



SITUATIVE

In this third intervention/stage the subject and his/her knowledge are exposed to the influence of his/her sociocultural environment (learner-centred). For this an initial form of Laurillard's conversational framework will be involved.

DATA COLLECTION AND USE

To collect data, a whole school anonymised survey will be conducted in which students will be asked about the method and frequency of teachers' use of technology in the classroom.

Prior to the interventions, teachers will also be interviewed and surveyed about their perceptions on the use of technology at school. Two more interviews will be conducted once one or two of the three aforementioned interventions have taken place, and at the end when all the training for teachers has been delivered.

A final survey for students and teachers will be conducted in order to capture any changes in perceptions that students and teachers may have once the interventions are completed.

After the final collection of data, the results will be analysed and discussed, and the final project will be assembled, contrasting the initial and the final responses data from students and teacher with a view to informing the research on whether there are any changes of mindset or not, whilst the remaining data would be used to inform the progression of the project.

"Nothing is built in stone; all is built on sand, but we must build as if the sand were stone"

- Jorge Luis Borges -

Appendix 7: Letter of consent to Parents

8th January 2018

Dear Parent/Carer

As part of my research project for my Masters degree at the University of Oxford. I will be conducting two interviews with a group of pupils who are willing to take part in the process. **The students will be interviewed in groups and their answers will be audio-recorded. The information collected in the interviews will remain strictly anonymous and only me or my supervisor at University would have access to it**. Furthermore, as part of the ethical standards of the University of Oxford I must guarantee that their answers cannot be traced back to them, and that the participation in this process has been entirely voluntary. **Consequently, your child is free to opt out of this process at any time, regardless of the stage which he/she may have reached.**

The intention of these interviews is to gather information on how pupils perceive teachers' use of technology prior to a set of interventions with the schoolteachers has taken place, as well as when the process has been finished.

The work will be done during this academic year, with the first interview taking place during the third week in January, and the second when the interventions and the process with the teachers has been finished. This is likely to be done in June. Should the date be modified, we will inform you through your child.

I thank you beforehand for your time and support.

Kind regards,

Mr _____

I_____, Parent/Carer of _____, authorise him/her to take part on the interviews carried out by Mr _____, in order to contribute to his research on learning and teaching.

Signed: _____ Date: _____

Appendix 8: Introductory paragraph to the surveys online

'This is a survey aimed at identifying the various uses of technology (specifically the VLE) at BGN. It forms part of a research project being conducted by Mr _____ in connection with his MSc studies at the University of Oxford, as well as being part of the VLE development plan for the year 2018-2019. **The information collected in this survey will remain strictly anonymous**, and the form has been specially designed with this purpose in mind. Please rest assured that your answers cannot be traced back to you. Furthermore, completion of this questionnaire is entirely voluntary. **Consequently, you are free to opt out of this process at any time, regardless of the stage which you may have reached in completing the questionnaire.**'

Appendix 9: Sample of Teachers interview

1. How would you describe your relationship with technology?
2. What does encourage you to use technology and what do you find difficult about working with technology?
3. Do you find technology useful to teach in your classroom?
4. How do you use technology in the classroom?
5. How do you use technology to teach?
6. Do you use the VLE? Why?
7. How do you use the VLE?
8. Does the VLE reduce your workload or does it increase it?
9. What do you think should be done in order to make the use of the VLE more effective?
10. How do you think your students would describe your use of technology in the classroom?
11. How willing do you feel when asked to work with technology? Why?

Sample of students' interview

1. Do you think that it is important for teachers to use technology in the classroom?
2. Do you feel that your teachers are able to implement and use technology to teach? Why?
3. If you had the chance to suggest technologies to your teachers to be used in your learning process… What would you suggest?
4. Do you feel that the VLE facilitates your learning? Why?
5. What would you like to see on the VLE to help you with your learning?
6. Do you use any kind of social media service (e.g. WhatsApp, Facebook, etc.) to create groups to discuss concepts or issues related to your lessons?

Appendix 10: Sample of Teachers' and students' questionnaires

Teachers' Questionnaire (the teachers' questionnaire was based on that developed by and available at http://tpack.org. For its use, I requested Dr Schmidt-Crawford's permission.)

	Strongly Disagree	Disagree	Agree	Strongly Agree
TK (Technology Knowledge)				
1. I know how to solve my own technical problems.				
2. I can learn technology easily.				
3. I keep up with important new technologies.				
4. I frequently play around the technology.				
5. I know about a lot of different technologies.				
6. I have the technical skills I need to use technology.				
CK (Content Knowledge)				
RE				
7. I have sufficient knowledge about RE.				
8. I can use a critical way of thinking and use interpretation.				
9. I have various ways and strategies of developing my understanding of RE.				

PK (Pedagogical Knowledge)				
10. I know how to assess student performance in a classroom.				
11. I can adapt my teaching based-upon what students currently understand or do not understand.				
12. I can adapt my teaching style to different learners.				
13. I can assess student learning in multiple ways.				
14. I can use a wide range of teaching approaches in a classroom setting.				
15. I am familiar with common student understandings and misconceptions.				
16. I know how to organize and maintain classroom management.				

PCK (Pedagogical Content Knowledge)				
17. I can select effective teaching approaches to guide student thinking and learning in RE.				
TCK (Technological Content Knowledge)				
18. I know about technologies that I can use for understanding and doing RE.				

TPK (Technological Pedagogical Knowledge)				
19. I can choose technologies that enhance the teaching approaches for a lesson.				
20. I can choose technologies that enhance students' learning for a lesson.				
21. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.				
22. I am thinking critically about how to use technology in my classroom.				
23. I can adapt the use of the technologies that I am learning about to different teaching activities.				
24. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.				
25. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.				
26. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.				
27. I can choose technologies that enhance the content for a lesson.				

TPACK (Technology Pedagogy and Content Knowledge)				
28. I can teach lessons that appropriately combine RE, technologies and teaching approaches.				

Sample of students' questionnaires

	Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**
My teachers often use technology in the classroom.				
My teachers often use the VLE as a tool for teaching and learning.				
My parents often check my reports the VLE.				
My teachers often use tools from the VLE other than to set homework or to upload files.				

Appendix 11: Responses to TPACK questionnaire

Question group	Question No.	Strongly Disagree	Disagree	Agree	Strongly Agree
	1	0	33	67	0
	2	0	11	78	11
	3	0	44	56	0
	4	11	11	78	0
	5	11	22	67	0
Q1 to Q6 TK	6	0	11	89	0
	7	0	0	44	56
	8	0	0	78	22
Q7 to Q9 CK	9	0	0	67	33
	10	0	0	56	44
	11	0	0	33	67
	12	0	0	44	56
	13	0	11	44	44
	14	0	0	44	56
	15	0	0	44	56
Q10 to Q16 PK	16	0	0	44	56
Q17 PCK	17	0	0	33	67
Q18 TCK	18	0	0	89	11
	19	0	22	78	0
	20	0	22	67	11
	21	0	56	33	11
	22	11	22	67	0
	23	0	22	78	0
	24	0	11	89	0
	25	0	0	100	0
Q19 to Q27 TPK	26	0	67	33	0
	27	0	0	100	0
Q28 TPACK	28	0	0	89	11

Appendix 12: Sample of maths teacher's task list

	#	Tasks	Resource	Options
	1	**Topic notes** Choose a topic to revise from the contents page in the revision guide. Read the relevant page(s) in the revision guide and make notes in your A4 revision book of the key points you need to remember.	There are no files associated with this task	
	2	**Practising questions** Choose a set of exam-style questions on your topic to complete, to check that you have understood the key points to revise. Select questions from Corbett Maths - links attached. Complete a few of the questions - choose a variety of questions to cover the whole topic. Use the videos (at home) and your revision guides to help you if you need it.	Corbett Maths	
	3	**Marking your answers** Use the written solutions to mark your answers. If you are happy that you are secure in this topic, tick it off your list and choose another one. If you are not happy, practise a few more questions.	There are no files associated with this task	
	4	**Practicing questions 2** Choose a set of exam-style questions on your new topic to complete, to check that you have understood the key points to revise. Select questions from Maths Genie - link attached. Complete a few of the questions - choose a variety of questions to cover the whole topic. Use the videos (at home) and your revision guides to help you if you need it.	Maths Genie	