



# Processes of practice and identity shaping teachers' TPACK enactment in a community of practice

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**Abstract** Technological, pedagogical and content knowledge (TPACK) has been used by hundreds of studies as a theoretical framework to explore teachers' technology use in classroom settings. While these studies have contributed to understandings of the interplay between these different knowledge domains and the differences between pre- and in-service teachers' knowledge, little work has been done to examine the influence of teachers' socially mediated workplace settings on TPACK enactment. This paper examines the impact of situated, social contextual factors on teachers' knowledge development and enactment by reporting findings from an eight month case study involving ten teachers in an Australian secondary school. Results reported in this paper indicate that TPACK enactment is influenced by processes of identity development and practice. These findings challenge the established position of knowledge as an epistemological possession inherent in the TPACK framework rather than also considering knowing as an epistemology of practice. Implications for in-service teachers and school authorities are discussed and three conclusions are presented.

**Keywords** TPACK · Communities of practice · Situated learning

## 1 Introduction

Teachers' use of digital technology in classroom settings has been characterised as a 'wicked problem' (Rittel and Webber 1973). In contrast to 'tame' problems that are bound and finite, 'wicked' problems, such as teachers' (non) use of digital technologies, are difficult to resolve. In this case, the complexity of the problem is manifested in the complex, contradicting and changing interdependencies between technological, pedagogical and content demands that are mediated by the situated social contexts that

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bound teachers' practice (Archambault and Crippen 2009; Cox 2008; Mishra and Koehler 2006; Mumtaz 2000; Shulman 1986; Somekh 2008; Straub 2009). Research investigating this problem, often using adoption-diffusion models as a basis, reports that technology integration is not happening, is happening too slowly or happening with little or no effect on student's learning (for example, see: Cuban 2004; Dynarski et al. 2007; Howley et al. 2011; Selwyn 2010).

The complexity of this 'wicked' problem and the varying results reported by research suggests that adoption-diffusion models do not adequately address the complexity of teachers' pedagogical uses of digital technologies. In contrast to studies using adoption-diffusion models, teachers' use of digital technologies has been examined through the technological, pedagogical and content knowledge (TPACK) framework (Mishra and Koehler 2006). While TPACK has been often used as a framework to measure teachers' knowledge and to explain teachers use and non-use of digital technologies, little attention had been paid to the socio-cultural processes that shape in-service teachers' TPACK enactment (Phillips 2013).

## 2 TPACK as a theoretical framework to understand teachers' (non) use of digital technologies

The TPACK framework builds on Shulman's (1986) delineation of teachers' professional knowledge as pedagogical content knowledge (PCK). The PCK framework differentiated teachers from content experts as expert teachers have a blend of pedagogical knowledge (PK) and content knowledge (CK) collectively labelled pedagogical content knowledge (PCK) in contrast to content experts' deference to CK.

More recently, Koehler and Mishra (2005) re-considered Shulman's PCK framework in an attempt to understand how the increasing use of digital technologies in schools might impact on the development of teachers professional knowledge. Subsequently, Mishra and Koehler (2006) expanded the PCK framework through the addition of technological knowledge (TK). Mishra and Koehler (2006) proposed that good teaching with technology involves a balanced combination of technological, pedagogical and content knowledge or TPACK. Mishra and Koehler (2006) represented their TPACK framework as three overlapping circles, with each circle representing a component of teachers' professional knowledge. This framework resulted in seven potential forms of teachers' professional knowledge with the aspirational TPACK positioned at the nexus of these circles. Bounding these different forms of knowledge is the context in which teachers' acquire and exhibit their knowledge as shown in Fig. 1.

The impact of the TPACK model has been profound and has been used in hundreds of studies examining teachers' professional knowledge (Graham 2011), with the majority of these using surveys to measure the extent of teachers' TPACK (Jordan and Dinh 2012). With such a proliferation of TPACK based research, it comes as little surprise that there is marked variation in the contexts in which investigations have examined TPACK. While these investigations have made valuable contributions to our understanding of the interplay between forms of professional knowledge in a variety of settings, in-service teachers' TPACK acquisition in their workplaces remains an under-explored context (for example, see: Jordan & Dinh 2012).

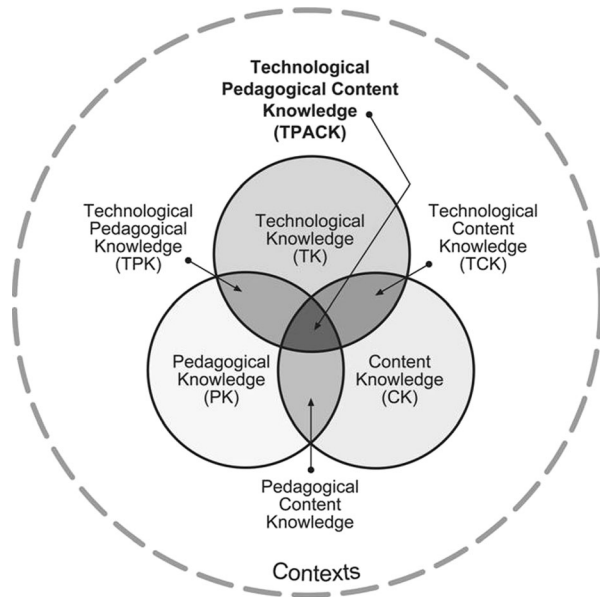


Fig. 1. The TPACK framework from <http://tpack.org/>

## 2.1 TPACK and context

One reason why TPACK acquisition and development (and PCK before it) has proven so difficult to measure is that knowledge must be acquired and exhibited in a specific context. Mishra and Koehler (2006) acknowledged the influence of context on teachers' TPACK enactment stating:

The core of our argument is that there is no single technological solution that applies for every teacher, every course, or every view of teaching. Quality teaching requires developing a nuanced understanding of the complex relationships between technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations. (Mishra and Koehler 2006, p. 1029)

The importance of context was also discussed by Cox (2008) who concluded that “the effect of context is that TP[A]CK is unique, temporary, situated, idiosyncratic, adaptive, and specific and will be different for each teacher in each situation” (p.47) therefore suggesting that “any true example of TP[A]CK must necessarily include the context of that example” (p.48). Despite Cox's (2008) indication of the importance of context, her extensive literature review revealed that much of the published research examining TPACK focused on measuring or defining forms of knowledge that are part of the TPACK framework and paid less attention to the context in which the TPACK is developed or enacted. The lack of attention placed on context is reflected in Cox's (2008) claim that while “an example of TPACK generally also contains an explanation of the context in which it took place, some of these examples are real and others are invented by the authors” (p.51). To position context as more significant, Cox's (2008)

contribution in clearly delineating aspects of the TPACK framework utilises Kelly's (2008) conceptualisation of context:

Included in the idea of context are such things as the school environment, the physical features of the classroom, the availability of technology, the demographic characteristics of students and teachers including prior experience with technology, the particular topic being taught, the preferred instructional methods of the teacher, etc. (Kelly 2008 as cited in Cox 2008, p. 47)

Kelly (2008) and Cox's (2008) expression of context as a location in which TPACK is enacted provides one way in which context could be interpreted; however, consideration of context in this manner has been criticised by more recent investigations such as the work done by Porras-Hernández and Salinas-Amescua (2013) who contribute one of the few examples of research that utilises a different understanding of context, providing an example of TPACK construction in a Latin American socio-cultural context. In addition to making a contribution to understandings of Latin American socio-cultural contexts, Porras-Hernández and Salinas-Amescua (2013) advocate for different understandings of context in the TPACK framework claiming that "the original TPACK framework is limited in that it defines the contexts in which teachers work too narrowly. In fact, the majority of published work refers to the context element in a rather general manner" (p.224). In contrast, drawing from the conceptual framework from Porras-Hernández and Salinas-Amescua, Rosenberg and Koehler (2015) provided a revised, particular definition of context in relation to TPACK and indicate that context can be considered as 'the conditions around the knowledge and activities of teachers' (p.2619).

While this clarification of 'context' provides some sense of direction for researchers, Phillips et al. (2016) argued the broad notion of the 'conditions around the knowledge and activities' may be enhanced by further consideration and refinement. Furthermore, Phillips et al. (2016) argued:

Previous research has considered the notion of 'conditions' from a variety of perspectives including factors inside the four walls of a classroom including 'the school environment, the physical features of the classroom, the availability of technology, the demographic characteristics of students and teachers including prior experience with technology' (Kelly 2008 as cited in Cox 2008, p.47), the broader socio-political conditions that exist within school workplaces (Phillips 2013, Phillips 2014) as well as systemic conditions associated with pre-service teacher preparation (Albion et al. 2010). The variety in these different contexts is reflected in Rosenberg and Koehler (2015) coding frame that categorises micro, meso or macro contextual levels; however, this characterisation of context amplifies additional challenges for TPACK researchers. (p. 3031)

A challenge facing researchers examining teachers' pedagogical technology choices is the selection of a framework through which teachers' acquisition, development and enactment of TPACK can be examined and analysed given the situated nature of teachers' practice. This study builds on previous literature that has argued for the suitability of Wenger's (1998) Communities of Practice (CoP) as a situated learning framework to learning to explore the socio-cultural influences on teachers' pedagogical

technology practices and identity transformations (Phillips 2013). In particular, this paper draws on Wenger’s (1998) notions of mutual engagement and identity outlined by Phillips (2012, 2013, 2014, 2015, 2016); Phillips et al. (2014)) and Phillips et al. (2016) as socially mediated processes that shape in-service teachers’ TPACK enactment.

### 3 Method

This paper reports on one case study developed as part of a larger, eight month case study investigation which generated cases of four teachers recruited from one co-educational government secondary school in Melbourne, Australia. In contrast to most schools run by the Victorian State Government, Drake Secondary College was a select entry school for students in Year 10–12 and promotes the pursuit of academic excellence in Science, Mathematics and associated technologies.

Examining the ways in which these teachers enacted their TPACK, the study drew on data generated from ethnographic observations and semi-structured interviews with the participants as well as from colleagues’ who had been invited by the teachers to participate in the study as their key professional learning colleagues. In total, ten participants contributed to the four cases investigated in this study, however, this paper will draw on data from the participants detailed in Table 1, particularly focussing on the ways in which process of practice and identity development shaped Anna’s TPACK enactment.

This research purposely did not consider how participants’ behaviour, or the processes described by Wenger’s (1998) CoP framework, may be explained by other theories. This research did not aim to validate Wenger’s (1998) CoP as a theory, but rather investigate if, from this theoretical perspective, themes and processes can be identified that help explain in-service teachers’ TPACK enactment. Consequently, the observed and reported enactment of TPACK in this investigation could be recast as examinations of power-relations, culture, gender differences, socioeconomic class or any other socio-cultural phenomenon, as these mediate the enactment of particular knowledge forms. However, it has been a deliberate choice not to do this and to address these issues to the extent that they emerge as significant themes which help to clarify the role of CoP. Indeed, “CoP as a social theory of situated learning is compatible with these socio-cultural influences in the way it considers them as personal histories and trajectories of identity” (Henderson 2007, p. 5).

**Table 1** Participant demographic data

Alias	Gender	Years Teaching	Curriculum focus	Positions of responsibility	Involvement in the case
John	Male	7	Mathematics, Physics	Deputy Head of Mathematics	Key professional learning colleague
Anna	Female	12	Mathematics	Daily Organiser	Core participant
Jake	Male	4	Mathematics, Physics		Key professional learning colleague

### 3.1 Methodological approach: Case study

Researchers provide different definitions of case study design depending on their emphases on either the process of conducting case research, the case as a unit of analysis or the end product of a study (Merriam 1998). Stake (1995) and Merriam (1998) focus on the unit of analysis and frame cases as ‘bounded’ or ‘integrated’ systems. Geertz (1973) illustrates the complexity involved in the notion of integrated systems describing the way in which such systems are situated within larger networks: how cases are always cases within larger cases, superimposed and knotted into one another and therefore are context specific. As Bulfin (2009) suggests, contexts are interactively achieved phenomena rather than predefined sets of forms and content; they are dynamically made and remade in the flow of everyday life. A question such as ‘where does phenomenon end and context begin?’ quickly unravels the idea that cases and contexts can be neatly bounded and traced. As Dyson and Genishi (2005) remind us, “cases are constructed, not found” (p.2).

This study builds on this productive tension between the blurred boundaries of case and context by recognising that cases and their boundedness are situated and interrelated entities which are only ever partially understood and always with reference to the range of intricate relations between the phenomenon and its biography and history (Mills 1959). This tension illustrates how context is not a static physical setting—it is not an empty container which holds or influences social action in a causal way. Instead, both context and case are constituted in and through language and social practices. The importance of context in understanding the ways in which teachers’ develop TPACK is central to this study and the relationship of both case and context to language and in particular social practices provides the necessary methodological practicality highlighted by Denscombe (2008) and discussed in the previous section.

Willis (2007), provides a broader contextual summary of case study research and suggests that case studies are “about real people and real situations ... [they commonly] rely on inductive reasoning ... [and] illuminate the reader’s understanding of the phenomenon under study” (p.239). In contrast, Yin (2009) begins his conceptualisation of case study by mapping different forms of qualitative research against different conditions and positions case study research as a method which responds to investigations asking how or why questions, where the researcher does not have control of the behavioural events yet the focus is on contemporary events. Following the presentation of the conditions most suited to case study research, Yin (2009) provides a more specific two part technical definition of case study research stating:

1. A case study is an empirical inquiry that
  - investigates a contemporary phenomenon in depth and within its real-life context, especially when
  - the boundaries between phenomenon and context are not clearly evident
2. The case study inquiry
  - copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result

- relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result
- benefits from the prior development of theoretical propositions to guide data collection and analysis. (Yin 2009, p. 18)

Empirical evidence for this investigation was gathered to examine this contemporary phenomenon within a real-life, secondary school context. The factors involved in the development of teachers' TPACK, are too numerous to quantify, let alone establish causality. The complex, contradicting and changing interdependencies between the technological, pedagogical and content demands and their mediation by the situated and social contexts that bound teachers' practices are unlikely to be effectively represented or explained by a simple equation.

These reasons support the use of case study as a suitable methodological approach for this study. This suitability is also supported by Johnson's (2001) review of literature utilising CoP as a theoretical basis. This review reports that "the vast majority of the current literature in this new research area consists of case studies" (p.45). This is borne out in a number of investigations (for example, see: Abramovich and Schunn 2012; Ayling and Flagg 2012; Barkley 2012; Jain et al. 2012; Kensler et al. 2012; Squires and Van De Vanter 2012).

#### **4 Analysis and discussion: Anna's case**

While considering the influence of other members of the Mathematics Teachers' CoP on Anna's TPACK development and enactment, this case particularly focuses on Anna's team teaching relationship with Jake. First, changes in Anna's TPACK enactment will be explored through an examination of the context in which Anna participates in her CoP. This exploration of context uses the CoP notions of identity and practice to explain how context can influence TPACK enactment. Second, this investigation explores Anna's identity and TPACK from three different perspectives and, in doing so, reveals that TPACK development is an ongoing process rather than an aspirational end point. Finally, Anna's team teaching relationship with Jake brings into question the conventional CoP notions of newcomer and old-timer as Jake, a comparative newcomer, influences Anna's TPACK enactment as well as having his own TPACK enactment shaped by Anna, a relative old-timer.

##### **4.1 Anna's identity: The influence of past participation, present competencies and future aspirations**

Anna's past participation in a variety of CoP has shaped her identity as an old-timer. She is an experienced teacher and administrator having taught for three years in Eastern Europe and for nine years in Australia, the last two at Drake Secondary College. In addition to her teaching roles, Anna has held Daily Organiser, Timetabler and Director of Reporting positions in a variety of other schools. The critique of the CoP framework in previous investigations (for example, see: Phillips 2012, 2013, 2014; Phillips et al. 2016) has revealed Wenger's (1998) conceptualization of identity. Wenger (1998) contends that identity cannot be considered as static but instead a 'constant becoming' (p. 154). Developing his argument for this perspective, Wenger (1998) asserts that our

identities are constantly changing, moving in trajectories that ‘incorporate the past and future in the very process of negotiating the present’ (p. 155). As such, Wenger (1998) argues that ‘the work of identity is always going on’ (p. 154) as we identify ourselves as much by where we have come from and where we believe we are going as by our current competence as members of a CoP. The following section will discuss Anna’s identity and trajectory within her CoP at Drake Secondary College.

One of her current roles requires her to start her work early each day as her first task after arriving at Drake Secondary College is to put in place a number of arrangements for the day ahead. Known in schools as a Daily Organiser, Anna is the individual that other teachers contact if they are going to be away from school for any reason. Daily Organisers are often responding to last minute telephone calls or emails from teachers who have become unwell, have to care for a sick family member or whose car has broken down on the freeway on the way to work. Finding last minute replacements to ‘cover’ classes left by absent teachers requires the ability to not only work effectively with technology to disseminate required information in a timely manner but also involves careful balancing and monitoring to ensure that the extra workload covering classes is shared equitably by all teachers in the school.

Understanding the subtle implications of these types of decisions requires knowledge of the ways in which teachers work within schools, irrespective of subject community differences. For example, an effective Daily Organiser who may not be a member of the Science Teachers CoP understands the problems associated with allocating extras (additional teaching to cover classes left by absent teachers) to teachers of senior Science classes in late May as they prepare students for important, externally assessed mid-year examinations. John, the Deputy Head of Mathematics, confirmed Anna’s strong administrative knowledge base and competence in her administrative role stating that Anna was ‘very, very organised and understands the different pressures we are all under’ and that she ‘knows how to get the job done’.

Notwithstanding Anna’s competent participation in this aspect of her work, she indicated that the knowledge and practices associated with her administrative role were often ‘too boring for me and time passes very slowly’. Despite demonstrating competence through practices developed through her previous experiences working in a number of administrative positions within schools, Anna was not seeking to strengthen this aspect of her identity by pursuing a trajectory that would see her completing more of the organisational tasks she finds onerous.

In contrast, Anna privileges her identity as a Mathematics teacher where she feels most useful over her administrative role where ‘time passes very slowly’. Anna stated on three occasions throughout the data collection phase of this research that she was not seeking to take on any additional administrative responsibilities and explained that she felt she ‘is most useful when [she] is in the classroom’. Anna’s affinity with classroom practices and knowledge was confirmed by Jake who felt that ‘she just couldn’t hack an office job because [she] needs that contact with students’, ‘she’s got good all-round [classroom] knowledge’ and ‘I learn so much from working with her because she is such a great teacher’. Jake’s opinion carries weight in this case as he is not only a member of the Mathematics Teachers’ CoP but, more particularly, he is Anna’s team teaching partner sharing the teaching of five classes with her. Anna also nominated Jake as a key professional learning colleague for this project. He is therefore in a unique position to observe and comment on her capacities as a classroom teacher.



While Anna participates as a member of the CoP at Drake Secondary College in a different role, her comments along with Jake's perspective reveal a preference for participation and identification as classroom teacher rather than as an administrator. It is in this role that Anna feels 'most useful' and this perspective is shared by others, for example Jake's claim that 'she is such a great teacher'. Despite Anna's preference to participate as a classroom teacher, there is part of her identity through which she is perceived as a competent administrator as seen in John's belief that as a Daily Organiser Anna 'knows how to get the job done'.

These two different trajectories therefore contribute to Anna's identity at Drake Secondary College. From a CoP perspective 'there is a profound connection between identity and practice' (Wenger 1998, p. 149) and this connection between identity and practice can help explain why individuals such as Anna 'often behave rather differently in each [context], construct different aspects of ourselves, and gain different perspectives' (Wenger 1998, p. 159). The differences in Anna's practices and identity when participating as an administrator or as a classroom teacher also draw on different forms of Anna's knowledge as 'every practice is in some sense a form of knowledge, and knowing is participating in that practice' (Wenger 1998, p. 141). Wenger (1998) therefore makes a connection between identity, practice and knowledge enactment (behaviour) that helps explain differences in behaviour exhibited in different contexts. The notion of context is also part of the TPACK framework reviewed earlier in this article and has been used by researchers such as Cox (2008) to explain why 'TPACK (and PCK) look slightly different ... for each teacher in each situation' (p. 47). Unlike the theoretical connections made by Wenger (1998) that show a connection between identity, practice and knowledge enactment from a socio-cultural perspective, context in TPACK research is more simply described as a location for the exhibition of knowledge. For example, Cox (2008), echoing Kelly's (2008) understanding of context, indicated that context in the TPACK framework can be thought of as:

the school environment, the physical features of the classroom, the availability of technology, the demographic characteristics of students and teachers including prior experience with technology, the particular topic being taught, the preferred instructional methods of the teacher, etc. (Kelly 2008 as cited in Cox 2008, p. 47)

Additionally, Mishra and Koehler (2006) discuss context as bounded by constraints such as 'subject matter, grade level, student background, and the kinds of computer and software programs' (p. 1032). Despite participating in these different contexts in different ways, it is debatable whether Anna's knowledge changes from one physical context to another. For example, it is unlikely that Anna's knowledge of technology, pedagogy or content change when she moves from her Year 10 Core Mathematics class to her Year 12 Mathematics Methods class in the next period.

In contrast to viewpoints that only consider context as the location for the exhibition of knowledge, examining context from a CoP perspective provides an additional perspective and language through which context can be understood as a socio-cultural influence on teachers' TPACK enactment. For example, the remainder of this investigation examines the ways in which mutual engagement and joint enterprise influence Anna's team teaching relationship with Jake and her desire to enhance her TK. Moreover, trajectory and imagination will also be shown as drivers for Anna's TK

development and enactment as she strives to maintain her competent identity as a classroom teacher.

This section has presented the theoretical connection between identity, practice and knowledge enactment (behaviour) from a CoP perspective through an examination of Anna's past participation, her present competencies and her future aspirations. The connection between identity and practice has added to previous TPACK descriptions that characterised context as the location for the exhibition of knowledge by providing an additional perspective and language through which context can be understood in terms of socio-cultural influences. The particular CoP processes shaping Anna's TPACK enactment will be analysed in greater detail later in this work through examinations of Anna's current and anticipated future practices and identity. These examinations of practice and identity will provide answers to Elkjaer's (2003) call for examples of *how* learning comes about through participation raised earlier in this book.

## 4.2 Exploring Anna's current TPACK from three perspectives

In addition to Anna's perspective, use of the CoP framework as a lens through which in-service teachers' TPACK enactment can be explored necessitates identity to be considered as a socially mediated phenomenon. Wenger (1998) argues 'we define who we are by the ways we experience our selves through participation as well as by the ways we and others reify our selves' (p. 149). In Anna's case, her perceptions of her identity, practice and TPACK will be compared with perceptions of Anna's TPACK expressed by her two key professional learning colleagues, Jake and John. In addition to the insights into Anna's current TPACK and future ambitions, this section will also reveal how multiple perspectives of an individual's TPACK can lead to a more detailed understanding of their TPACK strengths and weaknesses that are enacted in different contexts.

### 4.2.1 Anna's perspective

To elucidate Anna's beliefs about her own TPACK the author concluded the final interview with Anna by describing the TPACK model to her in some detail, explaining the different knowledge components and their overlaps as defined by Cox (2008), as well as showing her a printed copy of the TPACK diagram shown in Fig. 1.

Initially, the TPACK diagram was taken into the interview as a reference point for the researcher, however, as the interview with Anna developed the TPACK diagram was shown to her as she was becoming confused by the various combinations of knowledge that were being discussed. The TPACK diagram was used in the interview with Anna as a stimulus to elicit responses about the ways in which she combined different forms of knowledge and the ways in which she developed these forms of knowledge.

Utilising visual materials has been 'usefully employed as representations of a research domain and [to] act as stimulus materials in interviews' (Crilly et al. 2006, p. 341) and has been effectively used by a range of researchers (for example, see: Bagnoli 2009; Rose 2012; Varga-Atkins and O'Brien 2009). Despite the reported effectiveness of this approach, it should be noted that certain limitations exist with this process.

For this research, there are limitations on the strength of conclusions that can be drawn from such a process that presents knowledge in binary forms on a diagram. The *fuzzy boundaries* (Angeli and Valanides 2009; Archambault and Crippen 2009; Cox and Graham 2009; Jimoyiannis 2010) that characterise the TPACK framework and which were reported in earlier in this paper mean that any conclusions that rely on identification of exact locations on the TPACK diagram may be problematic as they may not take into account the dynamic relationship between TK, PK and CK.

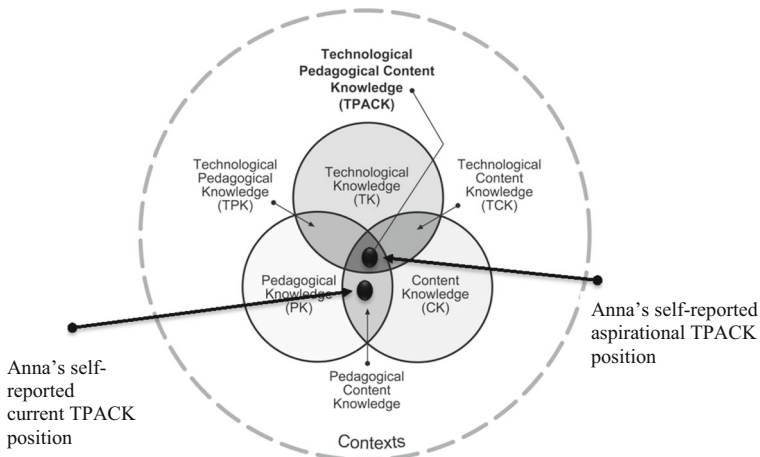
With this understanding of the TPACK framework, the author asked Anna to identify where she felt her knowledge would be best located. After looking at the TPACK framework depicted on an A4 page in front of her for approximately 30 s, Anna replied ‘I’m not in the middle because I am still missing some of the technological knowledge. So that will be my aim to be here’ pointing to the TPACK nexus.

While acknowledging the importance of Anna’s future aspirations, the author also asked her to indicate where she thought her current knowledge would best be represented on the TPACK diagram in front of her. Anna replied:

I think I am actually using technology for pedagogical knowledge, but I need more [pausing and pointing to TPK] ... I don’t have problem with this one [marking PCK on the TPACK diagram]. But I think that for now, I’m lacking the technological knowledge in this area [pointing to TPK], because I would like to start developing some more things in this [marking TPK] area.

Anna concluded her reply marking a point at the upper end of the PCK section of the TPACK diagram as shown in Fig. 2 indicating her belief about the best location for her current TPACK.

Anna’s comments are valuable for this investigation for two reasons. First, understanding Anna’s desire to be identified and participate as a classroom teacher rather than as an administrator Anna’s established earlier and her espoused desire to achieve TPACK, ‘that is my aim to be here [TPACK]’ reinforces the inherent tenet underpinning



**Fig. 2** Anna’s reported current and aspirational TPACK positions

the TPACK framework that dynamic transactional relationships between technological, pedagogical and content knowledge are required for effective teaching with technology.

Second, Anna's espoused desire to have a TPACK coupled with her preference to participate and be identified as a classroom teacher provides an example of Wenger's (1998) theoretical connection between knowledge, practice and identity. However, Anna's comments also reveal a different way of conceptualising TPACK: as future, desired knowledge that might support an imagined trajectory and identity.

Anna's identification of her lower TK, that she was 'still missing some of the technological knowledge' and her desire to 'start developing some more things in this [marking the TPK] area' illustrates that Anna was not only considering TPACK as knowledge that she had already formed and complete but that Anna also considered TPACK as knowledge in development. Moreover, Anna's reply when asked to indicate where Anna thought her current knowledge would best be represented on the TPACK diagram still included references to desired, future competencies, for example: 'I *would like to start developing* [emphasis added]'.

Wenger (1998) regards trajectory as an important part of identity development that is not 'a fixed course or a fixed destination ... [nor] a path that can be foreseen or charted but a continuous motion' (p. 154). Anna's case provides an example of this continuous motion. Anna's previous participation established her competent identity as both an administrator and classroom teacher. Her current participation and identification as an administrator sits in contrast to her preferred form of participation and identification as a classroom teacher. Furthermore, it is Anna's anticipated identity development as a competent classroom teacher that appears to influence Anna's anticipated TPK development.

Discussing Anna's TPACK not only showed her beliefs about her current TPACK but also revealed her imagined future trajectory and her desire to participate and be identified as a classroom teacher. Anna's comments indicate that to pursue this trajectory she feels as though she needs to develop her TK to achieve TPACK. Anna's espoused desire to enhance her TK provides a lived example of the way the CoP framework, in particular an imagined future trajectory, may influence an in-service teacher's TPACK enactment and thereby provide an example of how learning comes about through participation.

#### 4.2.2 Jake's perspective

As highlighted previously, use of the CoP framework as a lens through which in-service teachers' TPACK enactment can be explored necessitates identity to be considered as a socially mediated phenomenon. Wenger (1998) argues 'we define who we are by the ways we experience our selves through participation as well as by the ways we and others reify our selves' (p. 149). In Anna's case, we are able to compare her perceptions of her participation, identity and TPACK with those expressed by her two key professional learning colleagues, Jake and John, thereby gaining a range of perspectives about Anna's TPACK.

In a similar manner to the way the TPACK framework was explained and shown to Anna, both Jake and John were asked to discuss Anna's TPACK. In contrast to Anna's self-reported TPACK position in which she identifies her TK as being comparatively weak in comparison to her PCK, both Anna's key professional learning colleagues held a different perspective.

When looking at the TPACK diagram on the A4 piece of paper in front of him, Jake, Anna’s team teaching partner for five classes, stated that ‘all-rounder is a really good description for her. She’s got good pedagogical knowledge, really good knowledge of content and resources, really good ICT use. So she’s just that real all-rounder’. When asked to indicate where he would position Anna on the TPACK diagram Jake commented ‘I think in the middle. Her technological skill set is different from mine, but it’s still very strong. I feel she fits genuinely in the middle of this’ marking the TPACK nexus shown on Fig. 3.

Jake’s indication that Anna has ‘really good ICT use’ suggests that he believes Anna’s TK is higher than she believes while his claim that Anna’s ‘technological skill set is different from mine’ provides a distinction between Jake’s perception of his own TK and Anna’s TK. Jake’s belief that Anna is a ‘real all-rounder’ and has ‘really good ICT use’ sits in contrast to Anna’s belief that her TK, in particular her TPK, is weaker than other parts of her TPACK. In contrast to a singular conceptualisation of TPACK as an epistemology of possession (Cook and Brown 1999), knowledge developed ‘inside individual human heads’ (Simon 1991, p. 125), as an individually acquired, aspirational point (Phillips 2013) or as a static form of knowledge that, once obtained is not lost (cf Cook and Brown 1999), the contrast between Anna and Jake’s perception of Anna’s TPACK indicates that maintaining TPACK requires ongoing work and development, particularly in Anna’s case of TK.

While Jake located Anna’s classroom practices in the TPACK nexus suggesting she had strong PK, he also recognised that her ‘technological skill set is different from mine’. When asked to provide examples of these differences, Jake highlighted Anna’s extensive ‘collection of PowerPoints [from which she] is always able to find one which really summarises key information’. In contrast Jake indicated ‘I like dynamic sort of geometry software where kids can move things and you can see the effect and hope that

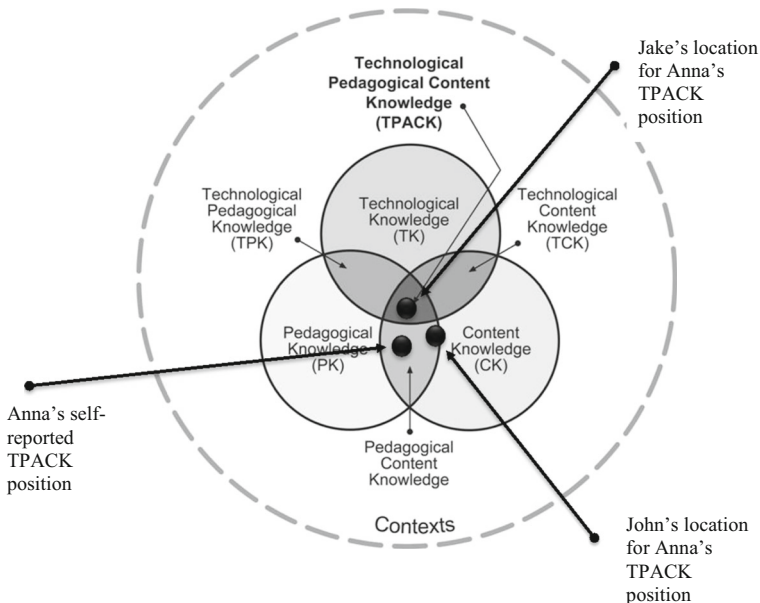


Fig. 3 Anna’s reported TPACK position

the students get more meaning from that than from a static image'. When asked where he developed his pedagogical preference for dynamic software, Jake indicated that his father was 'one of the first computer science teachers in the state so I have always seen and been interested in the ways in which teachers use different forms of new technology in their lessons', in particular 'the way my father was always looking for ways for his students to make sense of [content] for themselves by using technology'. Jake's digital technology preferences therefore differ from Anna's as he prefers students to be in control of dynamic software from which they can construct meaning at their own pace, in contrast to Anna's teacher focussed use of PowerPoint.

Anna confirmed Jake's belief about her use of PowerPoint presentations explaining 'there is not enough space to fit everything that you want to be on one board so they [students] can actually make a [conceptual] connection. With a PowerPoint presentation I can go backwards so they can see the connection'. Anna further explained that the ability to be able to go backwards and forwards and show the development of equations and graphs was important and reinforced her earlier comment that this was 'not possible in my past schools because I couldn't find a board big enough to fit it all on'. While Anna indicated that she had the technological hardware that enabled her to overcome the physical limitation imposed by smaller chalk or white boards, she also indicated that when using PowerPoint it was important to use technology in class as 'nowadays students are born with technology, they need something more visual. I really enjoy using technology because it is faster for me to bring the ideas to the students', 'I can create more accurate graphs for students to look at' and 'I want to do more [technologically based] things like Jake and John to improve the way we visualise [content] problems for students'.

Anna and Jake's differing use of PowerPoint provides one example of the different ways in which they used digital technologies as part of their classroom practice while teaching the same content to the same students at the same time. Despite their mutual engagement in planning and delivering their shared classes, the differences evident in the way Anna and Jake enacted their TPACK, in particular their TPK, draws into question the effectiveness of previous descriptions of context as part of the TPACK framework (for example, see: Cox 2008; Kelly 2008; Koehler and Mishra 2008) that only consider context as the location for the exhibition of knowledge or the physical factors that constrain or enable teachers' practices. In contrast, the differences in Anna and Jake's current and future TPACK enactment may be better explained by also incorporating considerations of identity and practice that consider ways in which their past participation (for example, making connections between TK and PK through Jake's familial participation) helps shape current practices and future identities. Understanding context as both a location for the exhibition of knowledge as well as a series of socially mediated processes that shape enactment addresses Hager's (2005) criticism of workplace learning theories that rely on single factor or universally applicable explanations.

#### 4.2.3 John's perspective

John, Anna's other key professional learning colleague and the Deputy Head of Mathematics, commented on different strengths in Anna's professional knowledge claiming 'her content knowledge is very, very good. And her technological knowledge is quite good now too'. However, when asked to indicate on the TPACK diagram

where he believed Anna would be best represented he said ‘she is pushing towards the centre. It’s difficult with pedagogical knowledge, because I haven’t taught with her in a classroom ... but yeah towards the middle’ while marking the bottom right hand corner of the TPACK nexus as shown in Fig. 3.

While a member of the Mathematics Teachers’ CoP, John’s professional relationship with Anna is different to her team teaching relationship with Jake. In contrast to Jake’s perspective developed through a mutual engagement in classroom practice as a member of a teaching team, John relies upon an understanding of Anna’s TPACK developed through emails, conversation, lesson plans and observation in professional development sessions ‘to [know] what kinds of activities she comes up with’. The ways in which John understands Anna’s TPACK and the ways she enacts TPACK are somewhat removed from observations of classroom practice ‘because I haven’t taught with her in a classroom’. John’s understanding is developed through different forms of interaction compared to the way Anna interacts with Jake. John’s abstraction from the classroom environment appears to limit his ability to make specific or accurate judgements about certain forms of knowledge, in this case Anna’s PK. John’s difficulty judging Anna’s PK because he ‘hasn’t taught with her in a classroom’ suggests that John feels as though he can’t accurately comment on Anna’s PK without observing her enacting her knowledge (her practice). This may mean that TPACK studies that rely on abstracted understandings of knowledge (for example, see: Barab and Duffy 2000; Barton and Tusting 2005; Drath and Palus 1994; Fuller et al. 2005; Gray 2004; Handley et al. 2006; Hildreth et al. 1998), such as John’s understanding of Anna’s PK, without seeing the enactment of that knowledge may be less informed than those understandings developed through observation of the enactment of that knowledge such as Jake’s understanding revealed in earlier.

While providing an additional perspective of Anna’s TPACK, John’s comments also reinforce the importance of changes over time when considering in-service teachers’ TPACK. John’s comments that Anna’s TK is ‘quite good now *too* [emphasis added]’ and ‘she is *pushing* towards the centre [emphasis added]’ indicate that from John’s perspective, Anna’s TK has developed from where it was at a previous point in time and that she is now closer to achieving TPACK than she may have been in the past. John’s comments confirm that TPACK connects past participation with current competence and when considered in Anna’s case with her desire to improve TK, future aspirations.

Figure 3 highlights a weakness with this representation of the TPACK framework; namely that the TPACK nexus is small compared to the six areas representing the other individual and overlapping forms of knowledge thereby making TPACK differentiation difficult. This difficulty is compounded when considering the way in which the overlapping circles representing technological, pedagogical and content knowledge are overlapped. In this case, this is evident in the location Anna chose as representative of her current TPACK. As illustrated in Fig. 3, Anna’s self-reported TPACK position was in the overlap between pedagogical and content knowledge. While this position provides a general sense of Anna’s belief about her relative TPACK strengths and weaknesses, this representation of her TPACK also indicates that she has no TK. While data presented in this investigation indicates that Anna believes her TK is weaker than her PCK, it is very clear that Anna does have *some* TK. The challenge therefore, is to develop a representation of TPACK in which the individual forms of knowledge are overlapped in a different way that allows for a more nuanced representation of an individual’s knowledge.

While the representation of TPACK used in this research presents some challenges, it is helpful to illustrate the relative position of Anna's TPACK indicated by each of the participants in this case. Figure 3 shows some differences in individual beliefs about Anna's TPACK, however the positions marked by Anna, Jake and John are not disparate suggesting that the TPACK model is useful as a method for broad identification. As such, general conclusions can be drawn from the identification of the location of Anna's TPACK by each of the participants in this case and the descriptions which accompanied them. In particular, one is able to surmise that:

- 1) Anna believes:
  - a) her PCK is stronger than her TK;
  - b) however, her TCK is stronger than her TPK;
  - c) that she aspires more TK to reach the TPACK nexus.
- 2) Jake believes:
  - a) Anna's TK, CK and PK are thoughtfully interwoven in her classroom practices;
  - b) while Anna has strong TK, it is different to his own;
  - c) her knowledge is best located in the centre of the TPACK nexus.
- 3) John believes:
  - a) that Anna's TK and CK are high;
  - b) with some reservation Anna has relatively strong PK;
  - c) she is 'pushing' towards and therefore may not have quite reached the aspirational TPACK nexus.

This summary serves to provide two reminders: First, TPACK may be judged from a communal perspective as well as from an individual's perspective. Anna's mutual engagement with John and Jake provides her key professional learning colleagues with an understanding of Anna's practices and her identity. Second, this understanding of Anna's practices and identity draw on her past participation and her future aspirations suggesting TPACK is both knowledge used to support current practices but it is also knowledge in the making. Anna's case shows how TPACK development is an ongoing process rather than an acquired end point.

Anna's imagined future trajectory in which she reinforces her identity as a competent classroom teacher by developing and enacting a stronger TK echoes Hager's (2005) theoretical proposition of a (re)construction metaphor. Anna's desired (re)construction of her TPACK, her practices and her identity helps to explain her mutual engagement and provides an additional example of how TPACK enactment is influenced in a CoP.

### 4.3 Team teaching and TPACK: Disrupting the newcomer / old-timer paradigm

The previous section provided three accounts of Anna's TPACK and highlighted Jake's particular understanding of Anna's PK resulting from his close professional relationship developed as Anna's team teaching partner. The remainder of this case builds on the details of Jake and Anna's team teaching relationship and will show how Jake and



Anna's relationship within a CoP disrupts the anticipated newcomer / old-timer identities described in the CoP framework. Furthermore, this section will show how the introduction of digital technologies into Jake and Anna's team teaching relationship was a critical factor in disrupting the expected apprentice / master identities and practices instead of promoting a relationship of reciprocity in which knowledge was shared and practices consensually negotiated. This section concludes that those looking through a CoP lens need to be cautious when simplifying the roles of members into categories of old and new.

#### *4.3.1 Anna and Jake: A teaching team with a reciprocal near-peer relationship*

As discussed earlier in this work, all classes in the school (with the exception of LOTE classes) are planned and taught by a team of two teachers. In contrast to an individual teacher working in a classroom, regularly teaching in a team replaces the 'pedagogical solitude' (Shulman 1993, p. 6) often experienced by secondary school teachers with a sense of teaching as 'community property' (Shulman 1993, p. 6). This change to a team teaching approach in this school represents a 'new event' placing 'new demands' (Wenger 1998, p. 154) on teachers in this CoP including Simon, the Principal of Drake Secondary College.

Despite working for 30 years in a variety of secondary schools, Simon indicated that the introduction of team teaching as a whole school approach was a new event for him claiming 'this is the first time in my life I've done something like this. This is very different for me'. One of the differences that a number of participants in this research mentioned in their interviews was the change in lesson planning. For example Nick stated 'planning in teams is very time consuming, more so than teaching by yourself'. Jake also mentioned the frequency of his communications with Anna regarding the planning of their shared classes:

we do team teach together a lot so have a lot of conversations when we're planning what we're going to do with our classes, about where we would like to get to and how we are going to teach. You want to know who is doing what and it is important to take the time to get it right.

When asked to expand on what he felt was important to 'get right', Jake stated:

I suppose it's a combination of things that we share when we are planning. I don't want to say resources because resources can just be shared. It's more like activities in the class or ways to structure our classes. I think we both have a very strong content knowledge so we often talk about the content for our classes but one of the main things is we talk about is the delivery of the content. We discuss our pedagogy and specifically how to work that.

Jake's discussion about his planning with Anna reveals a joint enterprise expressed through notions of shared practice, 'our classes' and shared activities, resources and structures. Both Anna and Jake's contributions to this joint enterprise also reflect Rogers' (2000) description of mutual engagement reported whereby members of a CoP engage in a commonly negotiated activity. Rogers (2000) also indicates that

through mutual negotiation, relationships form between members of a community. Anna also commented on the importance of regularly meeting with Jake to plan their shared lessons indicating that she would meet with Jake ‘each day for 10-15 minutes to plan what we are doing next and how we can approach that. We always try to have that conversation about what we will do next and how we will organise our next lesson’. Anna not only confirms the frequency of her meetings with Jake but also reveals a sense of mutuality as she mentions ‘what *we* are doing next’, ‘how *we* can approach that’ and ‘how *we* will organise *our* [emphasis added] next lesson’. This sense of mutuality was also evident in the language Jake used to describe his planning with Anna, for example: ‘ways to structure *our* classes’, ‘we often talk about the content for *our* [emphasis added] classes’. When describing their regular meetings, Anna and Jake are revealing their engagement in a socially negotiated activity (Rogers 2000) in which members form mutual relations of engagement (Wenger 1998); in short mutual engagement. The mutuality of Anna and Jake’s professional relationship not only shapes their TPACK, for example, ‘we discuss our pedagogy and specifically how to work that’ but also contributes to negotiations of the enactment of their TPACK or ‘how we are going to teach’.

Jake’s and Anna’s comments were confirmed in several researcher observations of their planning meetings typified by observations of mutual engagement such as ‘both [Anna and Jake] contributed to wide-ranging discussions about technological, pedagogical and content aspects of their upcoming classes’ (Researcher Observations). Anna and Jake’s comments and actions appear to reflect a common belief that they are sharing a class and confirm some of the positive findings from other research investigating teams of teachers such as Sandholtz (2000) who found that the careful selection of teaching teams can foster greater mutuality through collaborative professional classroom practices and collective resources. However, Jake’s comments reveal more than just the sharing of resources. Importantly for this research, Jake’s comments clearly indicate that he and Anna are sharing a range of practices and past experiences. For example, Jake’s acknowledgement that he and Anna talk about different activities and structures for their classes presumably requires them to share past experiences of activities or structures that have worked in past teaching experiences or to share an imagined possibility. In sharing an aspect of their past or imagined future, Jake and Anna are revealing aspects of one another’s past and future trajectories and in doing so create a present in which they share a repertoire or points of reference that provide a common discourse upon which Anna and Jake can negotiate their responses to knowledge and practices within the Mathematics Teachers’ CoP. Jake and Anna’s team teaching relationship provides examples of the ways in which identity, in particular the sharing of trajectories, can shape TPACK enactment.

This pairing of teachers therefore changes the context in which Anna and Jake enact their TPACK, particularly how they mutually engage with one another and align their practices to a joint enterprise through the development of a shared repertoire. As previously discussed, changes in the context in which teachers enact their practice can be understood as socio-cultural influences that not only include aspects of practice such as mutual engagement, joint enterprise and shared repertoire but also considerations of identity such as trajectory.

Researchers examining trajectory and identity through a CoP lens frequently explore trajectory as the transition from legitimately peripheral participant to centripetal

participant or from newcomer to old-timer (for example, see: Barab and Duffy 2000; Barton and Tusting 2005; Drath and Palus 1994; Fuller et al. 2005; Gray 2004; Handley et al. 2006; Hildreth et al. 1998). In this case study examining Anna's partnership with Jake, one could argue that Anna's extensive experience working in schools would categorise her as an old-timer, particularly in comparison to Jake's relative inexperience which could classify him as a newcomer.

Jake commented on the combination of old-timers and newcomers when considering the formation of teaching teams in the school:

they [members of the school leadership] try to match up teachers and look for a range of experience ... probably one consideration is to always to try to get a new staff member with an older one because then they [the older staff member] are more aware of what is going on so they can support them [the younger staff member] in that way.

When asked to consider the ways in which teams of teachers were created, Anna provided a contrasting explanation claiming 'that the ratio of young teachers and teachers like me in this school is balanced. So I think there is a big chance that you will always have that combination of a young teacher and a bit more experienced teacher'. Anna's comment reflects a belief that the selection of teaching teams is less strategic than Jake assumes there is a 'chance', albeit a big chance, that a newcomer will be partnered with an old-timer; however, both Anna and Jake indicate that the pairing of teachers at Drake Secondary College often involves a younger, less experienced teacher being partnered with an older, more experienced teacher and such pairings have positive benefits for the team.

The newcomer / old-timer continuum is also reflected in literature examining team teaching relationships. For example, Roth et al. (2004) and Jang (2006) presented research findings based on longitudinal data that show the careful selection of team teaching members can provide particularly rich learning experiences and professional growth for novice teachers. Implicit in each of these examinations of social relationships is the notion that master old-timers have expertise and experience through which they induct an apprentice newcomer.

However, a close reading of Lave and Wenger's (1991) work presents an alternative to the 'teacher/learner dyad' (p. 56) typically represented as newcomer / old-timer relationships. Lave and Wenger's (1991) alternative 'points to a richly diverse field of essential actors and, with it, other forms of relationships of participation' (p. 56) including 'young masters with apprentices or journeyfolk' (p. 57) who are 'relative old-timers with respect to newcomers' (p. 57) and can therefore be thought of as 'near-peers' (p. 57). Lave and Wenger's (1991) identification of near-peers provides an alternative to the binary newcomer / old-timer categorisation that dominates CoP research (for example, see: Barab and Duffy 2000; Barton and Tusting 2005; Fuller et al. 2005; Gray 2004; Handley et al. 2006; Hildreth et al. 1998) and appears to be particularly apt for Anna in her relationship with Jake as her experience and mastery is greater than Jake's but not as extensive as other old-timers such as Simon.

While providing an intermediate point on the continuum linking newcomers to old-timers, Lave and Wenger (1991) or Wenger (1998) do not provide any additional insights into the role of near-peers in the five cases that support their theorisation of

apprentices' transition from legitimate peripheral to centripetal participant. Moreover, Lave and Wenger (1991) or Wenger (1998) do not discuss the differences in near-peer relationships compared to newcomer / old-timer relationships.

Anna's team teaching relationship with Jake challenged the newcomer / old-timer binary often reported in CoP literature through the reciprocity evident in their planning meetings and in their observed interactions. In contrast to the apprentice / master relationship evident in many studies using CoP as a focus, Anna's case provides an opportunity to examine the role of near-peers as members of a CoP. In particular the final section of this work will examine the reciprocal nature of Anna and Jake's relationship to show the ways in which TPACK, practice and identities can be negotiated in a CoP.

#### *4.3.2 Negotiating relationships with near-peers*

Anna's professional relationships with Jake and John challenge the common representation of membership of a CoP as a 'teacher/learner dyad' (Lave and Wenger, 1991, p. 56). In contrast to the unidirectional flow of information from old-timer to newcomer, the previous section has argued that Anna's professional relationships with her two key professional learning colleagues, particularly with her team teaching partner Jake, may be better thought of as near-peer relationships characterised by relationships of reciprocity. Data presented earlier in this investigation revealed Anna's desire to improve her TK, in particular her TPK. This section will examine how Anna's near-peer relationships with Jake and John shaped her TPK while also illustrating the ways in which Anna's TPACK enactment shapes Jake's teaching practices as 'I learn so much from working with her because she is such a great teacher'.

Three perceptions of Anna's TPACK were explored in earlier in this work in which Anna revealed a desire to improve her TPK and it was this desire that was a motivating factor guiding who she liked to work with. Despite Anna's competent identity as an established and effective classroom teacher revealed earlier in this investigation, Anna chose to work with less experienced and younger teachers in an attempt to improve her TPK. When Anna was asked to explain why she nominated Jake and John as key professional learning colleagues she replied 'I really like to work with Jake and John because they are very good at using technology in class. I think they are the best people that can actually influence and improve my knowledge and use of technology'. Jake confirmed Anna's assessment: 'we're absolute nerds. We're thoroughly known as techno-nerds and we have very similar technological skill sets'. Similarly, Joanne the Head of Mathematics recognised similar competencies in Jake and John claiming 'Jake is as good as John in terms of innovative uses of technology I would say' while John indicated that there was 'a lot of overlap in our [Jake and John's] interest areas when it comes to technology'. Jake and John's use of digital technologies is recognised by multiple members of their CoP and contributes to their identities as 'techno-nerds'.

Anna's willingness to work with Jake and John to improve her TPK provides an example of workplace learning that contradicts the 'teacher/learner dyad' (Lave and Wenger, 1991, p. 56) that is a typical focal point of situated learning theories such as CoP. When further discussing her preparedness to work with Jake and John, Anna provided several examples of ways in which her key professional learning colleagues contributed to her professional development. Initially, Anna stated that she liked to

work with Jake and John because she ‘enjoy[ed] listening to their ideas about the way we can teach with technology ...moving from an old fashioned [approach] to improve with lessons with newer technology is fantastic’. Anna’s initial statement not only reveals that Anna was developing her TK through her interactions with Jake and John but that her TK development was shaped by listening to their ideas.

In addition to developing her TK by listening to Jake and John’s ideas about teaching with technology, Anna provided an additional example of how John shaped her enactment of her TK. In contrast to simply listening to ideas about ways in which TK could be enacted, Anna recounted a time when she:

wanted something similar to what John was doing [with his spreadsheets]. So I went to ask him. He showed me how to create it and after that it’s not a problem so now I can do it next time. But it was much easier to ask him than research how to do it on the [Inter]net. Sometimes it’s not explained well if you Google [for a solution] and you can’t ask questions if you get stuck.

Anna’s TK in this example was mediated through her CoP relationship with John. Anna indicates that her professional relationship with John helped her to enact her TK more easily than if she had attempted to find a solution to her technological problem herself. In describing how John showed her how to create the solution she wanted, Anna illustrates an example of the way in which a younger, less experienced teacher helped her shape her TK enactment. Furthermore, these statements indicate Anna’s preference for knowledge development and enactment in a socially mediated, participatory setting in which she can negotiate joint enterprise in contrast to her perception of learning from an Internet search that is more closely aligned to an acquisitional model of knowledge development.

Anna further explained that she would usually ask Jake or John rather than one of the other members of the school CoP, such as Hamish, the e-learning coordinator. Despite being a colleague with high TK, Anna would prefer to ask Jake or John because ‘Jake and John know what I actually want because they are in exactly the same subject. So instead of starting from ‘why I need this’ with Hamish, it is much easier because they [Jake and John] already know what I need’ and ‘it doesn’t need any extra explanation’. While Hamish is recognised as an individual with high TK, he is perceived as someone who could not help Anna with her particular, nuanced use of technologies in a Mathematics classroom nor her development of a competent identity within the Mathematics Teachers’ CoP. Anna’s preference working with John and Jake provides an example of the importance of a shared repertoire when developing TPK and TCK and illustrates that a shared approach to the development of practice, identity and knowledge is not easily understood by those outside a CoP.

Anna’s descriptions of her interactions with Jake and John have provided examples of the ways in which joint enterprise and shared repertoire can influence Anna’s TPACK and her enactment of this knowledge. However, Anna’s comments also reveal her willingness to work with Jake and John to develop her TK despite the fact that they are less experienced, younger members of the CoP. Despite their comparative inexperience, Jake and John’s identities as ‘techno-nerds’ appeared to provide Anna with opportunities to mutually engage with TK experts to enhance her own TK. Anna’s engagement with Jake and John sits in contrast to the expected unidirectional flow of knowledge and skills from masters to apprentices described in the CoP framework.

While Anna's TK is developed and shaped through her socially mediated interactions with Jake and John her relationship with Jake, evidenced earlier in this investigation is reciprocal and is characterised by the sharing of resources, activities and practices. Moreover, Jake's indication that 'I learn so much from working with her because she is such a great teacher' indicate that Anna's 'good pedagogical knowledge [and] really good knowledge of content' may be aspects of practice that he is developing as part of their team teaching relationship.

This section has explored Anna's reciprocal near-peer relationships with Jake and John and has challenged the expected newcomer / old-timer relationship which is reported in many studies using CoP as a theoretical lens. In contrast, it has demonstrated Anna's willingness to mutually engage with two members who are younger and less experienced teachers as their identities as TK experts provide her with the opportunity to develop her own TK. As revealed earlier in this investigation, Anna's desire to strengthen her TK is part of her anticipated trajectory and (re)construction of her identity as a centripetally participating classroom teacher. Anna's case therefore provides an example of the way mutual engagement in a reciprocal near-peer relationship can align with identity development and TPACK development in a CoP.

## 5 Conclusion

This work presented Anna's case through a focus on Anna's team teaching relationship with Jake. Discussion and analysis of this case has resulted in three main conclusions:

**(1) Processes of identity and practice constitute aspects of context in which an individual enacts their TPACK.**

Analysis of Anna's case highlighted the importance of the theoretical connection between identity, practice and knowledge enactment (behaviour) from a CoP perspective. In Anna's case, the connection between identity, practice and her TPACK enactment was revealed through her imagined future trajectory as a classroom teacher and her consequent TK development through her near-peer relationships with Jake. In particular, the connection between identity and practice exemplified in Anna's case adds to previous TPACK descriptions that characterised context as the location for the exhibition of knowledge by broadening out our understanding of context and through a set of socially-mediated practices.

This finding has theoretical implications for the TPACK framework as it changes the way the interplay between technological, pedagogical and content knowledge unfolds: first, context can be thought of as a series of processes grouped around practice and identity and these help to explain how TPACK development and enactment occurs in a workplace. Second, changes in TPACK can be considered as changes that occur in context, that is, TPACK may not change within an individual but the context in which it is situated may shape the way it is enacted among individuals. Third, Anna's case reveals that TPACK can be thought of as an aspect of trajectory that connects an individual's past participation in a CoP with his or her current competence and anticipated future competence.

The primacy of context, as seen in these three findings, broadens what comprises context to include practice and identity. It also unsettles assumptions of previous TPACK investigations that have attempted to measure current TPACK levels and

retrospective changes in TPACK without considering the socially mediated context in which TPACK is enacted.

## (2) **Mutual engagement reveals TPACK as knowledge in the making**

Anna's case presents three different perspectives of her TPACK. Comparing Anna's perception of her own TPACK with the perceptions of Jake and John provided an understanding of Anna's TPACK from a communal perspective as well as from an individual perspective. These different perspectives were valuable for three reasons: first, the value of mutual engagement in identifying TPACK was revealed as it was Anna's mutual engagement with John and Jake which provided her key professional learning colleagues with an understanding of Anna's practices and her identity.

Second, Anna's practices and identity drew on her past participation and her future aspirations suggesting that TPACK is a fluid concept. It is both knowledge currently possessed and used to support current practices but it is also prospective knowledge in the making. Anna's case shows how the constitution of TPACK and its development is an ongoing process rather than as an acquired static end point.

Third, Anna's imagined future trajectory in which she reinforces her identity as a competent classroom teacher by developing and enacting stronger technological knowledge echoes Hager's (2005) theoretical proposition of a (re)construction metaphor which presents an additional perspective to the often used acquisition and participation metaphors in workplace. Anna's desired (re)construction of her TPACK, her practices and her identity help to explain aspects of her participation in a CoP through mutual engagement; for example, the reasons for which Anna chose to mutually engage with John and Jake in a CoP despite their relative inexperience as secondary school teachers was to enhance her technological knowledge in pursuit of her desired future trajectory as a centripetally participating classroom teacher.

## (3) **Membership categories of newcomers and old-timers in a CoP require extension.**

Anna's case also challenged the old-timer / newcomer paradigm that dominates CoP research and indicates the importance of a near-peer in shaping TPACK development and enactment. Anna's reciprocal relationship with Jake in which both individuals helped the other to better enact their TPACK challenges the unidirectional flow of knowledge and skills from old-timers to newcomers described by the CoP framework. The implication is that researchers using the CoP framework might also consider members of a CoP not only in terms of the newcomer / old-timer dichotomy but might also consider midway points on the newcomer and old-timer continuum. In contrast to considering members of a CoP as fully formed old-timers or still to be formed newcomers, the additional consideration of members at a midway point encourages considerations of knowledge in the making.

Additionally, this finding has implications for those developing staff teams and professional development or mentoring programs in schools. In contrast to pairing a master (old-timer) with an apprentice (newcomer), school leaders seeking to develop effective teams of teachers should also consider the potentially valuable role of near-peers and the mix of TPACK expertise that sit within these positions in forming such teams.

In summary, this investigation has established the ways in which a professional's identity within a CoP shapes the enactment of their TPACK. It has been identified that the connection between identity and practice broadens out our understanding of context beyond the established considerations of context as the location of TPACK enactment. This draws attention to the socially mediated processes that shape practice and identity development and demonstrates TPACK as both current knowledge and prospective knowledge in the making. This fluid conceptualisation of TPACK in Anna's case helped to reveal the importance of near-peers in shaping prospective knowledge enactment in the pursuit of a desired future trajectory.

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