Blended Learning Environments to Support Teacher Professional Development Communities

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Abstract

With the prevalence of online communication in recent years, many teacher professional development (TPD) activities occur in blended learning environments which combine face-to-face (FTF) co-located experiences with online experiences. However, many scholars point out that blended learning environments need to be thoughtfully designed in order to integrate FTF learning with online learning experiences, and that there seems to be a lack of designs that pertain specifically to in-service teachers. Professional development is crucial for in-service teachers who are at the forefront of learning and teaching in the classroom. To impact student learning, deepening content knowledge and upgrading pedagogical skills are pivotal to teachers' professionalism. Building professional development communities through blended learning environments is a core strategy for teachers to grow their professionalism, considering the multitude of demands faced by teachers, especially in Singapore. With the aim of designing more supportive and sustained TPD communities through blended learning environments, we undertook a review of the literature. This review has resulted in a five R conceptual framework. We synthesised from the literature the observation that the design and development of sustained blended TPD communities involve multifaceted and complex issues. Such communities would need to hold strong relevance for their members, encourage close relations between members, enable rich reifications of artefacts, be well recognised by important stakeholders,

and lastly, be equipped with structural, digital, and human resources.

Introduction

With the prevalence of online communication in recent years, many teacher professional development (TPD) activities have shifted to the virtual world. Many of these professional development activities occur in blended learning environments, which combine face-to-face (FTF) co-located experiences with online experiences in which teachers are physically separated (Owston, Wideman, Murphy & Lupshenyuk, 2008). There are several benefits of blended learning environments for professional development, including help-seeking and giving support, access to teaching materials, and facilitating flexibility in learning (Ho, Nakamori, Ho, & Lim, 2016; Macià & García, 2016). However, Garrison and Kanuka (2004) point out that blended learning environments need to be thoughtfully designed in order to integrate classroom FTF learning with online learning experiences. Others report challenges for teachers such as time constraints, the lack of relevance of the topics discussed, and the remoteness of the community (Macià & García, 2016; Owston et al., 2008). While many studies focus on building blended learning environments for pre-service teacher communities or other learner communities, there seems to be very few designs that pertain specifically to in-service teachers (Ho et al., 2016; Macià & García, 2016; Matzat, 2013).

Professional development is especially crucial for in-service teachers who are at the forefront of learning and teaching in the classrooms. Besides impacting student learning, deepening content knowledge and upgrading pedagogical skills are pivotal to a teachers' professionalism. Building professional development communities through blended learning environments is a core strategy for teachers to grow their professionalism, considering the multitude of demands faced by teachers (Ho et al., 2016; Matzat, 2013). From a survey of Dutch TPD communities, Matzat (2013) found that blended TPD communities facilitated improvement of teaching capabilities, better understanding of subject knowledge and better access to information about teacher vacancies as compared to purely online communities. Teachers in blended TPD communities reported benefits from the intensive online discussions and resource sharing. They were more willing to trust each other, more motivated to share PD resources and interact with

community members (Matzat, 2013). These benefits are explained by the social embeddedness concept where FTF interactions build relationships between online community members.

In Singapore, the Academy of Singapore Teachers (AST) has been exploring the use of blended learning environments for building TPD communities. Guided by its underlying philosophy of "Teacher Ownership and Teacher Leadership", AST adopts three different modes of professional development for Singapore teachers. First, professional development is carried out through networked learning communities and professional learning communities where teachers engage in collaborative inquiry across or within schools to enhance their professional capacity and practice. Second, less experienced teachers are mentored by more experienced colleagues. Third, formal workshops, courses and learning programmes are conducted, sequenced appropriately to optimise learning for teachers. Many of these workshops and courses also incorporate blended learning.

Guided by the goal of contributing to the design of more supportive and sustained TPD communities through blended learning environments, we reviewed the literature on learning environments for supportive and sustained learning communities. The research question directing our inquiry was, "How can blended learning environments support and sustain teacher professional development communities?"

To address the research question, we adopted the following logic flow in our review methodology. We first reviewed the international literature to examine theoretical underpinnings, principles, or characteristics of professional development learning communities. These may be drawn from FTF, online or blended learning environments. Next, we identified case studies of TPD communities in Singapore to provide possible local perspectives. This is followed by a conceptual framework derived from a synthesis of the research evidence on supporting and sustaining TPD communities in blended learning environments. Further critique of the framework and its implications are discussed. The paper concludes with policy implications for the Singapore education system.

Literature Review: Learning Environments for Supportive and Sustained Learning Communities

Theoretical Frameworks and International Perspectives

The review of the literature revealed three theoretical threads of blended learning for TPD communities. First, many theories and principles were drawn from FTF contexts and were subsequently adapted for the blended learning environment. The second thread of theorisations and frameworks came from purely online contexts and were translated for the blended learning environment. Lastly, a more limited set of theorisations originated from a totally blended context. The review below is organised by these threads. Table 1 at the end of this section summarises the theoretical threads.

Face-to-face to blended. It is no surprise that many theorisations for TPD communities in blended learning environments originated from FTF circumstances. The movement towards learning in FTF communities stemmed from sociocultural theories that emphasise the active agency of the learner and the learners' learning in context (Kelly, 2006; Macià & García, 2016). One of the key theories is situated learning theory (Lave, 1988; Lave & Wenger, 1991).

Further extending situated learning theory, Wenger (1998) conceptualised communities of practice (CoP) which is a group of people with a common pursuit, sharing communally defined practices, beliefs, and understandings over a period of time (Wenger, 1998; Zagal & Bruckman, 2010). Three elements characterise a CoP: a domain of shared interest, a community of people who interact and build relationships, and a shared practice -a collection of resources such as experiences, stories, tools, and methods (Wenger, 2011). In the same vein, Barab and Duffy (2000) explain that a CoP has a common cultural and historical heritage, and holds socially negotiated meanings such as shared goals, meanings and practices. This system is both an interdependent and a reproduction system. Individuals are part of something larger as they work within a context and become interconnected to others in the community with whom they have a shared purpose. Also, new members engage in mature and established practices with other members in the community and become

exemplars, embodying communal practices; these members may even replace older members over time. Many professional development communities in blended learning environments have adopted and adapted these aforementioned sociocultural theories.

Owston et al. (2008) examined three TPD blended learning programmes in North America which were conceived based on concepts of situated design. Although these three programmes differed slightly in design and implementation, they shared the common goal of promoting continuous on-the-job professional learning through collaboration and sharing with colleagues. A cross-case comparative qualitative analysis revealed important characteristics of the programmes: relevance of learning experiences as teachers learn on the job and experiment with ideas in their classrooms; teacher-driven activities with teachers designing their own collaborative activities related to their curriculum; flexible timing to encourage online participation; minimal structures to enable teachers to extend deadlines or experiment with classroom activities; and emphasis on time allocation for sharing, both online and offline to give teachers ample time to discuss ideas, activities, successes, and disappointments. The study also found that such communities were stronger when teachers scheduled face-to-face meetings regularly, in this case, approximately every eight weeks, without a long gap of time between each online and face-to-face session. Additionally, the online component required the support of trained facilitators to keep teachers engaged.

Using the CoP paradigm, Liu, Miller and Jahng (2016) developed a framework which guided the development of a self-sustainable and democratic TPD community consisting of three main elements – teachers as knowledge creators, goal-centred praxis, and participatory media culture. The study argues that these elements are vital to any blended learning CoP as they underscore the issues of accessibility, collaboration, and commitment. Based on the framework, the researchers designed a series of five multi-week TPD workshops for enhancing in-service teachers' teaching of East Asian Studies topics at the University of Wisconsin with six to thirty teachers participating in each series. In each series of workshops, the participating teachers took turns to organise both FTF and online communications, sustaining the professional development community. Also, participatory media,

such as blogs and social networks, facilitated the development of teacher agency and professional capital as they steered teachers towards being knowledge creators instead of knowledge curators. Nevertheless, the study highlighted the need to not over-emphasise technology, but rather to emphasise the development of in-service teachers' voice, agency, and professional capital. The study concluded that the best structure for TPD community is self-organisation, where members take on freely chosen and modified roles and responsibilities to develop and maintain the community.

Indeed, situated learning and CoP theories have provided a strong theoretical framework for drawing up design principles for TPD development and sustainment in blended learning environments. Macià and García (2016) echo the importance of sociocultural theories. They did a systematic review of informal online TPD community research, which included a mixture of blended and purely online models, using articles published from 2009 to 2015. They found that CoP and sociocultural perspectives of professional development were the two most common conceptual lenses in the 23 relevant articles they reviewed, with 16 articles grounded in these theories.

Another FTF theorisation that was incorporated into the blended model is the lesson study model. Lesson studies (LS) are usually conducted physically with FTF planning and debrief, but Nickerson, Fredenberg and Druken (2014) incorporated a blended approach to lesson study to accommodate American teachers who worked in different sites and districts during a 3-year long PD on Algebra I (Mathematical content and students' mathematical thinking) for 80 teachers of Grade 3 from 26 schools. While the PD had several FTF LS meetings, a website with an asynchronous discussion forum and resources was used to support and extend collaboration among the teachers. This design involved onsite lesson observations followed by discussion of the lesson observed. Teachers shared online video snippets of their original and revised lessons, as well as reflections on both lessons, and their rationale for changes made to the second lesson. Suggestions to improve the online component included informing participants through email (push technology) of the start of new discussions, and linking the web platform to social media, such as Facebook, with which the teachers were familiar. The study found

the role of a coach (with protocols for coaches) useful to sustain and extend online interactions. Time was also provided by schools for teachers to attend the F2F component. Additionally, the researchers opined that teachers could have been attracted by the provision of lesson plans and videotaped lessons to log in to the online platform. However, when teachers initiated discussions, which were few, there was no sustained thread. There was also limited interaction across teams as participants did not feel comfortable discussing a lesson they had not observed. The limitation identified suggests the need for better coordination between FTF lesson observations and online discussion of the lesson. Nevertheless, this study showed the potential of a blended learning environment for LS, particularly when it involves long distance communication for teachers across multiple schools and districts.

To build communities that are supportive and sustaining, organisational commitment theory identifies three types of member commitment (Meyer & Allen, 1991): (a) continuance commitment, commitment based on the calculation of costs and benefits, (b) affective commitment, a positive emotional attachment or feeling of belonging to the community, and (c) normative commitment, a sense of obligation to the community in which members participate because they feel they ought to remain (Bateman, Gray & Butler, 2011; Meyer & Allen, 1991). These commitment types are not mutually exclusive, and individuals can experience them in varying degrees of desire, need, and obligation. Originally theorised in a FTF organisational setting (Meyer & Allen, 1991), member commitment types have been translated to blended and online environments by other scholars. For example, Bateman et al. (2011) examined a 50,000 strong voluntary online discussion community that was about 22 months old, and found that participant behaviours online were directly linked to their commitment levels. Participants who were affectively committed, compared to those normatively committed, participated more actively on the forum and helped to sustain the desirable aspects of the community such as community goals, values, and social structure. This was because affectively committed members saw parallels between the community's identity and their own. Continuance commitment, on the other hand, seemed to produce lurkers, members who merely consumed (e.g., read posts) but did not contribute content. However, lurkers provided an audience for content contributors, which is essential for community

growth.

A knowledge management approach has also been adapted for blended learning in TPD communities to support knowledge co-creation, internalisation, sharing, and evaluation. Ho (2016) developed a knowledge management-based TPD model in an in-service teacher-training course in Vietnam for a hands-on approach (HOA) course related to inquiry based learning. It was a 4-month course for 177 in-service secondary school teachers and government staff. The design principles for the blended learning group included the following: determining the purpose, co-creating content with instructors and learners, self-paced learning online, discussing and sharing views online, and reflection and evaluation at all stages of the course (including online tests, as well as sharing of final products via an online forum). A FTF course was also conducted. Participants of the blended learning group received course information, engaged in online discussions, had video-conferencing sessions and were assessed through an e-learning platform. On the other hand, participants of the FTF group listened to lectures, collaborated and presented with their peers in assignments, and took assessment tests in physical classrooms. The cross-case study analysis revealed that the blended learning community helped the teachers in their development of professional skills and teacher identity due to the following factors: (a) flexibility as learners could study anytime and anywhere through self-paced learning; (b) low cost and time use as travelling time and cost were reduced; (c) access to TPD resources and networks of professionals with useful skills and knowledge of TPD; (d) enhanced interaction as learners obtained knowledge not only from online lectures and materials, but also through activities such as discussion, observation, sharing evaluation of ideas, and giving each other feedback; (e) access to a professional network where teachers could develop their professional skills with support from the coaching and mentoring provided; (f) and organisational support from key stakeholders including school leaders.

Online to blended. The other set of theoretical underpinnings for blended learning environments for TPD communities are drawn from purely online contexts. Garrison, Anderson, and Archer's (2000) community of inquiry (CoI) framework is a key framework

that was developed in a distance learning programme with online discussion forums. The framework posits that learning occurs through interactions in a community of teachers and students. Three interrelated and mutually dependent factors are to be maintained in the online environment in order for learning to occur: social presence, cognitive presence, and teaching presence (Garrison et. al., 2000). Social presence refers to the ability of participants to project their social and emotional personality through interaction that allows for individual self-expression and risk-free sharing. Cognitive presence is how participants construct meaning through interacting within the CoI through questioning, exchanging information, connecting, and applying new ideas. Lastly, teaching presence refers to the facilitation of learning and direct instruction in the community, for instance by designing curriculum and activities, shaping constructive exchange, and focusing on or resolving issues. Teaching presence is not limited to one individual or the course teacher as anyone in the CoI may act to create a teaching presence (Garrison et. al, 2000; Vaughan & Garrison, 2005).

The CoI framework has been adapted to blended learning environments for PD. For instance, Vaughan and Garrison (2005) investigated how a blended learning approach can support cognitive presence (a part of the CoI) in a faculty development programme. This exploratory research studied 12 faculty members who were committed to redesigning their undergraduate courses into a blended learning format. The programme began with a half-day, FTF orientation session and continued with a series of six 90-minute bi-weekly FTF sessions, with a series of online activities after. The study found mixed responses to the online and FTF mediums. Participants preferred the FTF components as FTF was a more familiar communication mode that enabled creative and divergent thinking and took less time compared to the online activities. However, the topics of FTF discussions were often forgotten since there were no written records. Participants also shared that online sessions were useful for sustaining and expanding the scope of dialogue; the reflective nature of online communication enhanced reflective activities such as brainstorming and critical assessment of ideas and various teaching approaches.

Interestingly, several TPD community studies employed both the sociocultural perspective and the CoI framework. Caudle's (2013)

design of a TPD community was informed by the sociocultural perspective while the analysis was guided by the CoI framework. With a focus on mentorship, Caudle (2013) paid special attention to social and teaching presences in a blended learning community for in-service early childhood teachers. During the three months, FTF meetings were held as the central component, providing critical discourse and the development of co-inquiry, while online sessions enabled on-going communication and reflection. The research found two main roles related to social and teaching presences–facilitator (who coordinated community activities, scheduled and implemented meetings, facilitated discussions, and provided resources), and caretaker (who built trusting and respectful communal relationships, encouraged and motivated participants, and supported group cohesion). These roles did not exist independently and were often merged when appropriate in a situation. Also, both roles sustained the continuity of the FTF and online interactions. For instance, during a FTF session, the facilitator would observe connections between the participants' blogs and encourage conversations among the participants about their blog posts. The facilitator would summarise the discussion, and subsequently use the online medium to post follow-up questions to the group to extend the discussion.

Similarly, Paskevicius and Bortolin (2016) designed a blended professional development programme for teaching faculty members based on CoP and evaluated it using the CoI framework. In particular, the study investigated the sustainment of the community by designing an extended programme of nine months. Starting with a two-day FTF workshop, the nine-month programme continued with a series of month-long online modules followed by FTF meetings. The research found that participation online increased prior to the FTF sessions but decreased after FTF meetings. The decreased activity was partially attributed to end-of-year academic activities and heavy workload commitments. In this PD community, the three presences were maintained. For instance, teaching presence was maintained through the facilitators setting the agenda and learning outcomes, and illustrating how online activities can lead to deeper FTF sessions. Social presence was maintained by ensuring open communication and a safe environment, and cognitive presence through participants' questions and comments on connections between ideas. In addition, the study

highlighted the affordances of the online component to sustain communication through either initiating new ideas and/or extending discussions originating from FTF meetings, as well as through having focused online activities in line with the goals of the programme. The researchers argue that the blend of both FTF and online modes can create a richer experience for TPD than either on its own (Paskevicius & Bortolin, 2016).

Another online-only based theory is Salmon's (2000) five-level model for using computer-mediated communication (CMC). Motteram (2006) examined a 5-month blended learning Masters course in the UK that was designed based on this CMC model to demonstrate the use of CMC for teaching to teachers. The course consisted of FTF lectures, the design and trial of CMC with students, and an online component with web pages and an asynchronous forum. The online component followed five stages to develop students from novices to independent online learners. The five stages, described from the role of the e-moderator, are explained below:

- Stage 1: Access and Motivation. The e-moderator makes sure that students can access the system and provides basic activities to help novices build their technical skills. This helps increase their confidence in the new (both educational and technical) environment.
- Stage 2: Online Socialisation. The e-moderator encourages students to get to know each other online by exchanging messages and performing simple tasks together. This socialisation increases their confidence and forms the basis for collaborative work. Salmon (2000) intended socialisation in Stage two to foster an online community, which would develop in the later stages of the model.
- Stage 3: Information Exchange. The e-moderator helps students to discover new knowledge and exchange information about it.
- Stage 4: Knowledge Construction. The e-moderator encourages students to evaluate resources and create their own content. The greatest amount of interactivity occurs at this stage.
- Stage 5: Development. The e-moderator encourages students

to reflect on and evaluate their own learning. The aim is for them to become self-directed, independent learners.

While the teacher participants perceived the course as useful for giving them the experience of using technology for their own learning, some did not find the tasks meaningful as they were set top-down by the instructor rather than bottom-up, and some did not feel confident about expressing their ideas. The study shared design tips such as the need for an e-list (push technology) to inform participants when there is a new posting, and allowing anonymity to help participants who lack confidence in writing. This case study also highlights the need to balance the online and offline components to allow for sufficient time for each component.

Blended learning. Although the majority of the professional development studies reviewed have theoretical frameworks originating in FTF or online contexts that were translated to blended learning, the review found one study that was clearly conceived for blended learning. Hellmig (2008) developed a blended PD programme for Grade 5 in-service teachers featuring differentiated instruction in Mathematics and focused on blending five issues: (1) instruction and construction, (2) presence and distance, (3) individual and community, (4) content and experience focus, (5) "traditional" media and e-learning. Over a school year, the programme had four FTF meetings with three eight-to-twelve weeklong professional development phases supported by a Moodle learning management system for online communication. The programme was facilitated by two moderators with different expertise (theory and practice) who involved participants in discussion, activity and reflection, and a combination of individual learning and reflecting with collaborative learning. The study found that an important factor in motivating participants to practise their knowledge was engaging more than one teacher from a school in a group. The participants were 44 teachers of Grade 5 classes in five courses in Germany. The research found that participants paid more attention or responded more often for online activities which sent automatic daily alerts compared to those without automatic notification. Many participants gradually started to reflect and/or planned their lessons as the programme continued. Their self-reports were more than a simple reflection of their learning; they included details of their experience and behaviour, which point to

an impactful PD. The researchers also underscored the importance of organisational support in sustaining teachers' PD, as such support relieved teachers of the logistics of arranging relief from teaching duties and other tasks. However, the use of the online learning management system created more obstacles, such as technical issues, and generated fewer discussions as compared to the FTF activities.

In sum, the three theoretical threads from our international review are summarised below (Table 1).

Table 1. *Summary of the international review*

Origins	Theory/Study	Brief Explanation	Connections with Blended PD
FTF	Situated learning	Knowledge is gained in context through authentic circumstances Learning relies on interactions with others, involving sharing and negotiation	The combination of online and FTF extends the opportunities for interaction and caters to different preferences with regard to interaction.
	Communities of practice (CoP)	A community of people with a common pursuit sharing communally defined practice and understanding Needs a domain of shared interest and a shared practice.	It is unlikely that a short term blended PD would develop or sustain a CoP. To sustain a blended CoP, it is critical that participants have a shared interest/ goal and have a say in the design and conduct of the PD activities.
	Lesson Study	Involves joint planning of the lesson, lesson observation and then discussion of the lesson observed	Involves a mix of onsite lesson observations and sharing of video snippets of the original and revised lessons Lesson planning and debrief can be done FTF and/or online, to support and extend collaboration among teachers.
	Organisational Commitment theory	Identification of 3 commitment types: continuance, affective, and normative	Affective commitment, which involves a feeling of belonging, is an important factor in participants' involvement in online activities. Continuance commitment tends to produce lurkers. However, these lurkers have a role to play as audience for content contributors.
	Knowledge Management	Involves knowledge co-creation, internalisation, sharing and evaluation	To sustain blended PD, participants need to be involved in determining the purpose, co-creating content, and reflecting on their learning

Online	Community of inquiry	Learning occurs through interactions in a community of teachers and students. Requires three factors: social, cognitive and teaching presence	The reflective nature of online communication can enhance the facilitation of reflective activities such as critically assessing ideas and teaching approaches. Teaching presence need not be limited to an individual. Social and teaching presences require two roles: facilitator and caretaker.
	Salmon's (2000) five-level model for CMC	Stage 1: access and motivation Stage 2: online socialisation Stage 3: information exchange Stage 4: knowledge construction Stage 5: development	The stages can be used to design blended PD, with the moderator's role corresponding to each stage explained. Each stage can be supported by a blend of online and FTF interaction.
Blended	Hellmig (2008)	Blending 5 aspects: a) Instruction and construction b) Presence and distance c) Individual and community d) Content and experience focus e) Traditional media and e-learning	Findings included the importance of engaging more than one teacher from a school, and organisational support.

Local Case Studies

Besides the international literature, local case studies were reviewed, given that the Singapore context has a uniqueness that the international literature does not address, that is, relatively near distances between schools, a highly centralised curriculum and teachers performing co-curricular and other duties after school. Local studies on blended learning TPD are relatively few but our review found the following cases that provide some evidence of the potential of blended learning for TPD communities in Singapore. A summary table of the local case studies is provided in the Appendix.

Blended video-based PD using lesson studies. Based on the lesson study model, a blended video-based model was created for a TPD programme of one academic semester involving 5 mathematics teachers at one secondary school in Singapore (So, Lim, & Xiong, 2016). This TPD programme was co-designed by researchers at the National Institute of Education (Singapore) and the participating teachers, and included individual and collaborative annotation activities in online and FTF settings. The adapted lesson study involved the following sequence of activities:

- Teachers and researchers study the curriculum and identify topics of interest for examination, specifically topics that can be

better taught with ICT integration
- Teachers write/revise instructional plans for implementation in video-taped lessons
- All teachers conduct and videotape their own lessons in the classroom
- All teachers individually annotate the video of a particular teacher, using DIVER software
- Teachers compare, discuss, and analyse annotations as a group in weekly meetings with researchers, each lasting approximately an hour

The study found that providing a platform for teachers to annotate the videotaped lessons in their own time led to productive and in-depth conversations during the FTF group discussion. The annotation tool itself supported teacher learning by facilitating the identification of complex situations and offering features like guided noticing, annotation, and repeated playback. Teachers found that the videos made it possible for them to do in-depth analysis of interactions (discourse and physical action) on a moment-by-moment basis as videos offer visual depiction of interaction behaviours and ease of reference. In addition, teachers were pleased to be directly involved in choosing lesson topics. However, sharing ideas and observing colleagues' classes were not part of the culture of the school, and teachers were concerned about making critical remarks about other teachers or receiving critical remarks about what they said or did. The facilitators used guiding questions to direct the flow of the discussions, allowing the participants to better formulate their thought process and engage more deeply in meaning making.

This study was conducted in a small TPD community, and its smallness is relatively commonplace in Singapore where professional learning usually takes place within school-based subject disciplines. The maintenance and sustainment of the blended learning LS community was not the focus of the study and not reported; we suspect that this TPD programme is unlikely to continue in the school when the research activity ceases. Still, the study has yielded evidence of the feasibility of blended learning for TPD communities, both practically and theoretically, with the appropriate supportive culture and tools.

Sustaining professional learning within the teaching community through technological innovation. In contrast, the next case illustrates a larger and longer-term TPD community across schools in Singapore. With the focus on partnering teachers for educational technology innovation reforms, a learning community (LC) was formed in 2013 comprising teachers seconded to a unit in the Ministry and teachers in schools (Shaari & Hung, 2017; Shaari, Lim, Hung, & Kwan, 2018). The community aimed to enable teachers to acquire the principles underlying an innovation for enactment in their classrooms, take ownership of the innovations to enhance their teaching, and introduce the innovations to their peers (Shaari & Osman, 2015). Shaari et al. (2018) and Shaari and Hung (2017) offer a full treatment of the case studies.

The seconded teachers (facilitators) were assigned to share and seed ICT innovations through various initiatives and through the LC. The LCs used a combination of agile, iterative work processes, and informal approaches to increase teachers' involvement. For example, the LCs divided up tasks (e.g., developing lesson plans) into small manageable pieces for the teachers to manage the tasks themselves. Breaking up tasks enabled development to occur in short phases of work, allowing teachers to frequently reassess the tasks to adapt lessons to their classroom context. Informal approaches included unstructured activities where facilitators and teachers learn and share together, for example, facilitators and teachers going on field trips together and designing lesson plans that concretise the teachers' experiences beyond the classroom. Besides FTF meetings, online communication platforms included using Slido for mass interactions to solicit real-time feedback and active discussion, and WhatsApp groups and emails for small group communication.

There were sub-LCs, that is, smaller and more topic-focused learning communities, formed in the process. These sub-LCs were strong in developing dyadic ties that we believe are an important first step towards online learning communities.

The Open Source Physics (OSP) sub-LC is an exemplar case that blends technology with FTF interactions. The OSP sub-LC uses computer applications that were developed as a public collaboration

with an open source ethos and made freely available; users are also encouraged to share their codes with other users. The computer applications include simulations, which can be modified and customised, to visualise physics concepts. The OSP sub-LC assisted students and teachers to create, use, and customise computer models or tools to suit their learning context and instructional needs (Wee & Mak, 2009). The OSP sub-LC is associated with the OSP international communities, which was started by Christian, Esquembre, and Barbato (2011) as a National Science Foundation funded project to provide tools and resources for interactive computer-based modelling.

Adapting publicly available computer applications contributes to catalysing the blended learning that transcends local and international boundaries. For instance, the OSP sub-LC members interact through FTF and online with local teachers and their international counterparts in exchanging information, and sharing computer application models. They meet in OSP workshops, seminars, conferences, and MOE's Physics Instructional Programme Support Group (IPSG) to create, adapt, and use the computer models for different classroom needs. OSP members reflect on their learning journey and generate reports to concretise their reflections.

Overall, the research found that teaching practices across the LCs were influenced by the provision of shared contexts. LC dialogues were facilitated by the sharing of individual teacher's experiences in the use of educational technology innovations. LC facilitators enabled the customisation of innovations to align with the Singapore school curriculum. For example, the innovations included publicly available computer applications that could be modified to address each teacher's particular classroom needs. The customisation efforts resulted in teachers building relationships with each other, as illustrated by the OSP sub-LC.

However, the study also found that teachers as participants had limited time and were constrained by their daily operational roles in school. The current approach overstretched the LCs capacity for deep learning because experimenting with educational technology innovations was constrained by curriculum time and syllabus. The LC model involved highly interactive FTF interactions with one teacher at a time, thus

making it difficult to sustain the effort required to customise innovations. School management may be slow in appreciating the value of LCs, and this can hinder teachers' efforts in integrating ideas learned in the LC into their classroom practices or school-wide programmes.

Knowledge Building network of learning communities. Another professional learning community currently existing in Singapore and actively sustained is the knowledge building (KB) network of learning communities (https://www.kbsingapore.org/). Knowledge building practices require teachers to make use of students' ideas as a constant source of information with the goal of transforming a classroom into a community of learners (Mohammed & Teo, 2016). Teachers need to have the competency to identify potential students' ideas to sustain KB by employing procedure-based and principle-based action, and they need adaptive expertise that supports continual learning, improvisation, and expansion.

Arising from these needs, a KB network was formed and grew over time (Mohammed & Teo, 2016). The earliest inception was a project arising from a Ministry of Education initiative in 2010 known as Prototyping Pedagogies for Learning with Technology (Propel-T), which led a group of education officers and teachers to meet to start KB lessons (Ministry of Education, 2015). A collaborative KB site was built soon after by all involved. From 2012-2013, a slightly larger group of teachers tried KB with the focus on improving their individual practices in the classroom. This was widened to school level in 2014, when localised models of KB classrooms were initiated in each school. Subsequently in 2015, teachers from different schools met more regularly (e.g., at least twice a year), and in 2016, the structure became known as the KB networked learning communities. This community has about five lead schools who take turns to host a session attended by all the KB communities in the network.

While this community meets predominantly FTF, there are several online components. KB practice requires the use of an online knowledge forum platform, and this is the primary medium used for students' knowledge co-creation, and the display of artefacts for teachers' further comment and expansion. Teachers also make use of the platform for their own discussions, which extend and supplement

their FTF meetings. Additionally, the community has developed an overall KB community website and individual working blogs for each lead school. These school blogs "contain the reflection and journals of teachers and school teams" and are "meant for restricted viewing to provide a safe space for reflection" (https://www.kbsingapore.org/school-blogs/). The research notes the importance of school-based PD to engage teachers in mapping the curriculum, finding connections across concepts and helping them to reflect on the role they and their students play in a KB classroom (i.e., to help teachers make a conscious decision to release ownership of learning to students). School-level PD also helps the rest of the school visualise how KB pedagogy can be sustained and possibly adopted in other subjects, and how it can involve middle management and school leaders. However, one challenge for the network is the constant change in participating members, resulting in fluctuations in levels of expertise and passion. A further observation is that this KB network has regular interactions with a larger global network (e.g., KB Summer Institute) that involves interactions with consultants and experts at times (e.g., https://www.nie.edu.sg/news-detail/knowledge-building-(kb)-symposium).

Blended learning for in-service Chinese Language teachers. TPD is conducted not only in school environments, but also outside school environments. A blended learning course was conducted in a higher education institute's centre for training Chinese Language teachers (Tan & Tan, 2017). Using socio-constructivist theory, a 10-hour in-service teacher workshop was planned and implemented over 2 weeks. Teachers met FTF at the beginning and the end of the workshops with online interactions in between. During FTF sessions, the instructor facilitated discussion to identify topics of interest related to the central theme. The online discussions were used to extend the classroom interaction beyond the FTF meetings. The participating teachers were asked to provide a response within 24 hours and to initiate and sustain discussions. Suggested dates for posting responses to the discussion forum were given in the timetable. The workshop used a discussion forum for threaded discussions and a Facebook group for learner reflections.

The study found that a transition period is needed for teachers to adopt self-regulation habits. The instructor created a WhatsApp group to

send reminder messages to increase the response rate, provided a timetable of tasks to be done, and added ground rules for interactions and deadline information. The instructor had to support the teachers' transition to an unfamiliar style of learning. She provided a safe and low-pressure environment for participants to express ideas (e.g., no single right or wrong position about different perspectives) and encouraged divergent views. It was important to develop rapport with and among participants at the start of the class. The research highlighted the need to build a climate of trust and openness to encourage social meaning making in blended learning.

In addition, there was a conscientious effort made by the instructor to promote learning by encouraging teachers to construct their own knowledge. The instructor refrained as far as possible from spoon-feeding the teacher participants, encouraging them to explain their ideas and provide their own examples. The instructor promoted interactions through a process of enculturating teachers into reflective inquiry practices, and encouraging them to think actively. This boosted teachers' intrinsic motivation to learn and become autonomous learners.

The instructor of the blended workshop faced several challenges. She found it challenging to synthesise ideas in classroom discussions. She felt a need to summarise these ideas as key points during FTF discussions. She assumed that participants were not learning if they did not post responses online. After some discussion with colleagues, she managed to change her view and accepted that the participants could be learning even if they were not active in posting. The paper emphasised that the professional development of instructors who are facilitating blended learning is critical. Instructors need to be prepared for the impending challenges, and provided time to learn and explore the novel approach of blended learning. Peer support can be provided for instructors to explore new ideas and handle issues in blended learning design.

Designing a Blended Synchronous Learning Environment. Another local case study in higher education was reported recently by Wang, Huang and Quek (2018). The authors describe the design of a blended synchronous learning environment (BSLE) for a pre-

service teacher course. This design enables online and FTF classroom students to participate in identical class activities in real-time (Wang et al., 2018). The BSLE allows students who are unable to travel to the physical class venue due to injury, mobility problems, or social and family commitments to attend class at a location convenient to them, thus reducing the number of absentees. In the study, the BSLE was created using a two-way video conferencing system to enable online students to attend the sessions at multiple sites (e.g., at students' homes) simultaneously with students physically present at the class venue. There were four BSLE sessions in the 13-session course. Students took turns to attend the online lessons with each student attending one BSLE session on average.

Through iterative stages of designing, the study mapped out several design principles of BSLEs: design easy and clear activities that can accommodate online and FTF participants simultaneously, encourage partnerships in the learning environment such as pairing an online student with a FTF student, and ensure clear video and audio communication of high quality with online students. An additional principle was that instructors should balance attention between online and FTF students, to engage both and neglect neither. The study reported that online students found it difficult to ask questions and get the instructor's attention, while FTF students felt that it was unnatural to communicate and collaborate with online participants during group work. Still, the study showed that a BSLE design had the capacity to extend features of FTF instruction to online students. Students enjoyed the flexibility and convenience of attending lessons online from remote sites. While this was a pre-service course, it provided a glimpse of the potential advantages and difficulties of blended learning environments for in-service teachers.

Synthesis and Conceptual Framework

Based on the reviewed theoretical lenses and empirical studies, a conceptual framework was synthesised for enablers that support and sustain blended TPD communities. Given that there are constraints to building such communities, the synthesis has focused on the design principles that address these obstacles. Overcoming constraints is the other side of the coin, and our conceptual framework offers strategies that are all-encompassing enablers to address the research question

(i.e., how can blended learning sustain TPD communities?).

The conceptual framework is named the five R framework and is depicted in Figure 1. The five R framework draws on an earlier conceptualisation in Shaari and Osman's (2015) report on the use of LCs for encouraging teachers to adopt educational technology innovations in their classrooms. As its name indicates, the framework has five enablers that support and sustain blended TPD communities: relevance, relation, reification, recognition, and resources. The first four Rs are blocks that build the support and sustainment while the fifth R serves as the foundation.

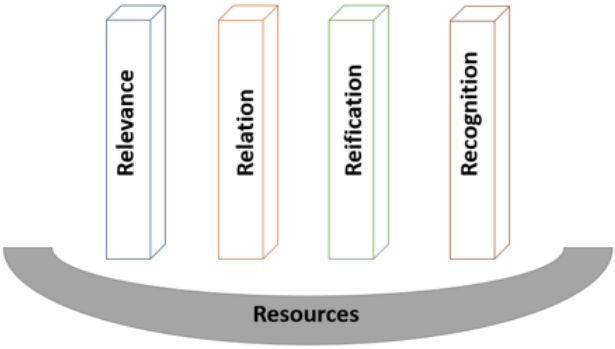

Figure 1. *Five R conceptual framework for sustaining blended TPD communities*

Relevance

Relevance refers to clearly meeting the needs of the members of the TPD community. Relevance requires that the purpose of the community must be made clear to participants, so that they see the value of the blended TPD community and why they ought to participate in it. Thus, TPD communities have to emphasise areas of common concern (Mohammed & Teo, 2016; Owston et al., 2008; Wenger 1998; Zagal & Bruckman, 2010), such as instructional demands encountered by participants or technological innovations for teaching that participants are expected to master (Ho et al., 2016; Motteram, 2006; Nickerson et al., 2014). Some participants may not see the importance of the TPD community. They could be persuaded by ensuring the usefulness

of the content and resources shared (e.g., lesson plans, video links), and by demonstrating the expertise and leadership qualities that may be gained through learning from participation in the TPD community (Liu et al., 2016; Nickerson et al., 2014; Paskevicius & Bortolin, 2016). Bateman et al. (2011) add that members need to see the unique value of the community that is not available elsewhere, and propose sharing stories of members who had gained from the community. Also, the topics and content of discussion in the TPD community have to relate to participants' authentic work contexts (Lave, 1988). While it is not possible for all the needs of participants to be met, there could be priority needs that cater to various groups. Some customisation and/or targeted contributions to stimulate or seed discussion might even be necessary to cater to unique needs (Bateman et al., 2011; Shaari et al., 2018).

Meeting the needs of participants has to be designed to occur in both online and FTF interactions (Macià & García, 2016; Nickerson et al., 2014; Owston et al., 2008). In both settings, the PD model aims to move from a teacher- or trainer-centric model of sharing information to a learner-centric model that encourages participant-learners to set the agenda so that they feel a sense of ownership of their PD.

Additionally, one of the key needs that blended learning TPD communities must inherently address is the convenience of access to the learning community. This is especially so if participants are from remote areas or dispersed localities or teach in different schools (Hellmig, 2008; Liu et al., 2016; Nickerson et al., 2014). Convenient online access reduces the number of physical commutes to TPD meetings, enhancing the pragmatic possibility for such programmes and communities (Nickerson et al., 2014).

Through clearly meeting content and convenience concerns, the building block of relevance supports and sustains a blended TPD community.

Relation

A second important building block of blended TPD communities is the relationship between participants in the community. Relation addresses relational issues between and amongst participants. This is a step

towards building supportive and sustainable TPD. There are four sub-aspects to the design of relationship building, a) community roles; b) facilitator roles; c) community norms; and d) complementarity of interactions.

a) The roles in a community need to be deliberately designed to enable positive relations amongst participants (Barab & Duffy, 2000; Garrison et al., 2000; Hellmig, 2008; Liu et al., 2016). First, the targeted community membership must be established in line with the purpose (e.g., is it an open community, or is membership limited for a time-specific aim to learn a certain approach), and the minimum number of participants for an optimal community size must be decided (Hellmig, 2008; Macià & García, 2016). The community should have a mix of self-organised and assigned roles to enable participants to take ownership in the community (Liu et al., 2016; Owston et al., 2008). Also, any participant should be allowed to take on the role of teacher or facilitator (Garrison et. al, 2000; Vaughan & Garrison, 2005); this builds collaborative relationships among teacher-participants, and emphasises the principle that members are co-partners in teaching and learning. The roles should be flexible such that members can move in and out of various roles, and also in and out of the community as needed (Barab & Duffy, 2000; Liu et al., 2016). Lastly, the negatively perceived role of 'lurker' in the online environment can be repositioned. The literature suggests that such observers should be acknowledged and not ignored (Bateman et al., 2011).

b) The role of the facilitator is crucial to building relations in a blended TPD community. The facilitator initiates, sustains, extends, and evaluates cognitive and relational interactions within online and FTF mode, and also between online and FTF modes (Caudle, 2013; Motteram, 2006; Nickerson et al., 2014; Owston et al., 2008; Salmon, 2000; Shaari et al., 2018; So et al., 2016; Tan & Tan, 2017). Different members can serve in cognitive and socio-emotional facilitation (Caudle, 2013) and through formal and informal ways (Shaari et al., 2018). Additionally, training for facilitators as well as peer support are also important to help facilitators engage the community,

manage their roles, and better troubleshoot issues (Nickerson et al., 2014; Owston et al., 2008; Tan & Tan, 2017; Wang et al., 2018).

c) Community norms in the blended TPD community is the third element in relation and refers to the setting of rules and encouraging behaviours that build positive relationships in the community (Hur & Hara, 2007; Motteram, 2006; Owston et al., 2008; Paskevicius & Bortolin, 2016). The norm of a safe and constructive environment must be established to allow participants to trust others to the extent that they can share frank opinions and mistakes, to foster a sense of belonging, and encourage collaboration. In some cases, setting deadlines may be necessary to build a responsive culture (Tan & Tan, 2017). In addition, participants need to be able to project their social and emotional personality (social presence) online and FTF (Paskevicius & Bortolin, 2016). Providing for anonymity could encourage a safer environment and more discussion (Motteram, 2006).

d) Complementarity of interactions refers to the design of complementary FTF and online meetings and interactions to build relationships among participants. Interactions should be regular and connected. A schedule of online and FTF meetings to discuss issues and resolve challenges is recommended (Caudle, 2013; Owston et al., 2008). Meetings need to be regularly held and not scheduled too far apart from each other so as to develop long-term relations and trust among participants. Also, a strong content link between online and FTF interactions is needed (Caudle, 2013; Nickerson et al., 2014; Paskevicius & Bortolin, 2016), for example, extending FTF ideas in ensuing online discussion and activities, and discussing issues raised in an online interaction in the subsequent FTF session.

Reification

The third building block of blended TPD communities is reification. In contrast to the emphasis on community connections in relations, reification focuses on the cognitive development of members of the community. Wenger (1998, p. 58) defines reification as “the process of giving form” to one’s experience through “producing objects that congeal” learning experiences “into ‘thingness’”. The practice of sharing

in TPD communities is marked by concretisations of cognitive learning, such as pedagogical innovations in authentic learning settings that result in the iterative creation and customisation of specific artefacts (Liu et al., 2016; Motteram, 2006; Wenger, 2011). In blended learning environments, reification is achieved through engaging participants with multiple opportunities (online and FTF) for externalisation and sharing of knowledge, and with practical cognitive activities such as participant-led content creation using social and/or participatory media like blogs, websites, videos, and Instagram photos (Liu et al., 2016; Mohammed & Teo, 2016; Nickerson et al., 2014; Owston et al., 2008). Reification is also made possible through harnessing technological affordances for the creation of artefacts. These may include online simulations of end products (Shaari et al., 2018), and the visual and reflective affordances of online tools to facilitate teacher noticing and deeper reflective activities as well as its documentation (Caudle, 2013; So et al., 2016; Vaughan & Garrison, 2005).

In addition to technological tools for facilitating the creation of artefacts, mechanisms through which to share individual reification experiences and obtain collective feedback are important. These include online feedback sessions, access to artefacts, and opportunities to customise and refine artefacts such as lesson plans, worksheets, and videos (Shaari et al., 2018). Through participant-driven construction of meaning via collaborative development of plans and other artefacts, reification supports and sustains the blended TPD community.

Recognition

Recognition, the fourth building block of blended TPD communities, assures participants of formal approval and acceptance of TPD by persons whose approval matters to the participants. External stakeholders could be the participant's reporting officer, school leaders, senior management, the teaching fraternity, family members, government officials, students, parents, and society. For instance, Ho et al. (2016) and Hellmig (2008) both highlighted the importance of key personnel support (e.g., school leaders and government officials) for participants' involvement in a blended TPD community. In contrast to relevance, which is internal motivation for the participant, recognition is external motivation. The external parties need to see the value of TPD, which generates much professional knowledge and social capital for

participants.

Recognition mechanisms such as micro-credits towards certification, awards, or scholarships for courses, or participation in conferences can help foster supportive and sustainable teacher PD networks. In particular, treating TPD, especially its online components, as an integral part of normal workload is imperative. Several studies have noted the decline of TPD communities due to demands from other work regarded by employers as normal workload (Paskevicius & Bortolin, 2016; Shaari et al., 2018). In sum, tangible recognition mechanisms help to provide the required recognition from significant stakeholders.

Supporting and sustaining blended TPD requires recognition of its value, in the form of tangible recognition mechanisms issued by significant stakeholders.

Resources

Resources are the bedrock of sustained blended TPD communities, and refer to any collective materials, affordances and/or individual skills, expertise or experience that are available for sharing. Thus conceptualised, resources blur the divide between individual tacit skills and collective affordances when they are brought together in blended PD. They are viewed as inseparable for both the individual participants and the collective are driven by the common goal of raising teacher professionalism, and both individual and collective resources have to be made available. Three types of resources are identified: structural, digital, and human. These types of resources or infrastructures in various ways facilitate the operation of the four building blocks of blended TPD.

Structural infrastructures mainly address the issue of availability of time to participate in blended TPD communities (Nickerson et al., 2014; Shaari et al., 2018). Time needs to be allocated for interacting in the blended TPD community. Flexible and/or extendable timing and deadlines for tasks and discussion should be integrated into the design of the TPD (Ho et al., 2016; Owston et al., 2008).

Digital infrastructure refers to technological access and artefacts in blended TPD. Digital resources include (a) funding for digital technology

(Shaari et al., 2018), (b) ease of access to the online platform for participants in diverse circumstances (Hur & Hara, 2007; Shaari et al., 2018; Wang et al., 2018), (c) provision of training on the use of the technology (Hellmig, 2008), (d) online facilities to enable sharing of ideas flexibly and anonymously if anonymity is needed (Motteram, 2006), and (e) push technologies such as email notifications and group chat messages that can be strategically used to inform and remind participants of community interactions and/or events (Nickerson et al., 2014; Motteram, 2006; Salmon, 2000; Tan & Tan, 2017). Digital resources can also be various pooled resources and digital assets (e.g., Twitter, online videos), digital tools enabling interactions that build ideas and provide feedback (e.g., co-writing tools), or forms of digital recognition of participants' performance (e.g., digital badges), in other words, technological resources that allow participants to create, share, and collaborate easily (Liu et al., 2016; Macià & García, 2016; Wang et al., 2018).

Human infrastructure comprises the skills, expertise, and experiences brought to the blended TPD community, both by participants providing individual skills and expertise to build collaborative knowledge as well as external personnel contributing external expertise (Ho et al., 2016; Shaari et al., 2018; Zagal & Bruckman, 2010).

Table 2 provides a summary of the five R framework and its design principles.

Table 2. *Five R conceptual framework for sustained blended TPD communities*

Enablers	**Design principles**
Relevance: clear value to participants	Emphasise areas of common concern and provide for useful customised interactions online and FTF
Relation: roles, norms and interactions in the community	Build communicative and safe relationships among participants by defining roles in the community, setting constructive norms, and regularising and connecting modes of interaction.
Reification: iterative creation and customisation of artefacts to concretise TPD learning	Provide multiple opportunities (online and FTF) for practical activities that externalise, construct and refine understanding.
Recognition: external stakeholder support for blended TPD	Create tangible mechanisms of significant stakeholder support such as micro-credits, awards, and allocation of time even for the online component of PD
Resources: collective materials, artefacts, affordances, and individual skills, expertise, capacities and experience that are available for sharing	Provide structural (e.g., flexible timing), digital (e.g., push technologies), and human (e.g., consultants and TPD experts) resources to support the TPD

Discussion and Implications

The literature review has uncovered several tenets of supportive and sustained blended TPD communities from theoretical papers and empirical studies conducted outside and in Singapore. The principles gleaned from the literature review have been conceptualised in a five R framework delineating five important factors in building sustained blended TPD communities: relevance, relation, reification, recognition and resources. Resources serve as the foundation for the other four Rs, providing the basic infrastructure for the creation of relevance, relation, reification, and recognition. In particular, the literature reviewed has generally foregrounded relevance and relation as key design factors in sustaining participants' involvement and managing their interaction through processes such as the provision of needed learning experiences and supporting the socio-emotional connections of participants both online and FTF (Garrison et al., 2000; Nickerson et al., 2014; Owston et al., 2008). As mentioned earlier, besides building relations, supportive and sustained TPD communities have to engage in concretising learning through reification (Wenger, 2011). While relevance is an internal enabler, recognition is an external motivator (as implied in Ho et al., 2016). In other words, these are flipped sides -relation with reification, and relevance with recognition, with all five Rs serving as building blocks in the construction of a supportive and sustained blended learning TPD community.

The studies reviewed in this paper feature many communities with a fixed timeframe as they were sited in a course or programme. There were very few TPD communities that were planned for a longer-term trajectory with no specific end date (e.g., Matzat, 2013; Mohammed & Teo, 2016). With reference to our first building block of relevance, the timeframe of a blended TPD community reflects the value and specific purpose of the community. Once that purpose is achieved, the community naturally expires. A fixed timeframe for TPD communities may be advantageous, as it defines the commitment participants are expected to give to the community. For instance, Tan and Tan (2017) found that participants in a two-week course were expected to respond to the online discussion within 24 hours of the questions posed. However, with a fixed short timeframe, when the relevance has not been fully realised or the purpose not completely achieved or other related purposes have been found, there seems to be limited ways or

even no way to continue the community. If there are no continuity plans, it potentially defeats the purpose of forming of the community; starting to build the community might even be a futile exercise. The prospect of a short-lived community suggests that time-bound communities need to fulfil their relevance within the planned time frame or make pre-arranged provisions to extend the life of the community to ensure its continuance. The problem raises, for blended TPD community designers, the question of whether to plan for continuance or a fixed period.

Blended learning environments may offer more convenience and save travel time as compared to FTF-only communities. On the other hand, typing online could be slower and can require more effort than speaking FTF. The extent of travel time saved in Singapore (where commute time is relatively short) is probably not much of an advantage compared to communities in countries where members are spread across a larger area and in more remote locations (e.g., Nickerson et al., 2014). Thus, blended learning TPD environments in Singapore need to offer participants a more compelling value proposition promising benefits other than convenience. The relevance of the community needs to be extremely enticing, perhaps a more holistic and sustained TPD model that addresses a crucial gap in teachers' development, and that makes teachers feel nurtured and inspired through participation in complementary and connected FTF and online environments.

Recognition of participation in a blended learning TPD community is one of the building blocks in the five R framework. Several studies have recommended that even passive forms of participation such as lurking in the online component ought to be acknowledged (Bateman et al., 2011; Nickerson et al., 2014). Developing ways of visualising and/or representing less active ways of participation, such as the use of digital badges, could help increase members' activity in blended learning. Another approach is to regard less active members as listeners engaged in 'e-listening', which is a necessary step in directing attention to ideas (Wise, Hausknecht, & Zhao, 2014). Additionally, ensuring that participation in a blended learning TPD community, especially the online component, counts in teachers' workload is a form of recognition that is worth serious attention.

The framework conceptualises a set of resources comprising individual capacities and material artefacts that can be made available for sharing. Whether these resources can be easily made available and shared is another question. Resources are limited and distribution can be difficult. Which communities will be able to secure the resources they need to be supported and sustained? In a country like Singapore, with a relatively small population and a teaching workforce of about 33,000 (Ministry of Education, 2017), what is the possible number of communities that can be supported and sustained? There are many intersecting and overlapping networks, posing the problem of finding sufficient members to collaborate and play various roles. Moreover, it seems ideal to have diverse voices providing feedback and shaping ideas. Thus, it is more likely that blended TPD communities in large countries and international blended TPD communities will last and be successful. The implication is that blended learning TPD communities in Singapore need an international membership with some members actively participating from beyond its shores. A case in point is the OSP LC (Shaari & Hung, 2017; Shaari et al., 2018) which has international and local members. It is possible that the foreign voices add more diverse perspectives to the interactions, thereby increasing engagement and sustaining the community.

From our review of both the international and local literature, we found that blended TPD communities were quite similar. All communities were concerned with time issues and the challenge of designing online and FTF cognitive and relational activities. However, in the local studies, we observed a slightly stronger need for instructor control. The voices of instructors (or facilitators) of the TPD community featured more prominently than those of the participants, and the agency of participants in articulating what they wanted to learn and what was relevant to them was assumed or not given much attention. In contrast, many of the international studies reiterate the importance of the flexibility of the community's agenda to allow participants to develop their professional capital (e.g., Liu et al., 2016). It must be acknowledged, however, that we reviewed only a small number of local studies and they may not be representative of possible TPD communities in Singapore. Nevertheless, the challenge of creating inclusive and flexible agendas to increase and enhance relevance is an area that needs further negotiation and examination. An instructor-

driven blended learning model tends to be usual in Singapore rather than a learner-centred one. A shift towards more learner-centred blended learning pedagogies can occur, but this would require more blended learning innovations and adequate time to take root.

Lastly, our derived framework and design principles draw mainly on literature conceptualised originally for FTF or online contexts. There are limited conceptualisations that originate in pure blended learning environments. The scarcity suggests the need for more theorisation of blended learning communities in view of their growing popularity.

In particular, the following policy suggestions are recommended:

- Consider commissioning more local research on blended TPD communities, for instance, rich case studies on professional learning communities (PLCs) and networked learning communities (NLCs), and quantitative and/or mixed methods studies to examine existing TPD communities and teacher attitudes towards such communities, as well as the optimal balance between FTF and online.
- Encourage reflective practices for teachers in the blended learning environment. This would enable teachers to easily reflect in these environments and take up the role of facilitator to extend reflective practices among participants. If more help is needed, experts can be engaged to conduct regular workshops for teachers on strategies and pedagogies of reflection.
- Develop an enticing value proposition for blended TPD communities in Singapore. The value proposition might offer a holistic TPD community designed to address a pertinent unique gap in teachers' shared practice or knowledge (e.g., new innovations, interdisciplinary learning) that blended learning environments can fill by providing access to multiple perspectives, which are important as teachers try to make sense of complex concepts such as the Singapore Teaching Practice.
- Supplement NLC FTF meetings with pertinent online professional development learning opportunities.

In conclusion, the design and development of supported and sustained blended TPD communities involve multifaceted and complex issues. Our 5 R framework theorises that the development of a successful community is built

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Summary of blended TPD local case studies

Local studies	Context and goals	Technology tools	Benefits and challenges
Blended video-based model	5 math teachers in one secondary school over one semester To design, implement and critique ICT-based lessons	DIVER software for teachers to annotate videotaped lessons	Annotating videotaped lessons in teachers' own time prompted productive in-depth conversations during the FTF discussion Teachers were not comfortable critiquing other teachers' lessons
A TPD community involving teachers and officers from a unit in the Ministry	Involved teachers from schools and Education Ministry officers To share and seed ICT innovations through the learning community	Two modes of online platforms were used. For mass interactions, to solicit real-time feedback and active discussion, Slido was used. For small group communication, a WhatsApp group was created to facilitate follow-up discussion, complemented by emails and face-to-face meetings. Use of open source codes to develop and customise computer models	The breakdown of tasks into small manageable pieces enabled the teachers to adapt the innovation for their classroom contexts. The use of open source enabled participants to customise computer models. The main constraint was time for experimenting with and customising the innovations.
Knowledge building network of learning communities	A long-term community of teachers from different schools who believe in KB pedagogy and implement it in their classes	A collaborative knowledge building site which includes individual working blogs for the five lead schools https://www.kbsingapore.org/ An online knowledge forum platform is used to extend teachers' discussion in their FTF sessions (on average twice a year)	This network has regular interactions with a larger global KB network which provides access to consultants and experts. A challenge is the constantly changing membership.
Blended learning for Chinese Language teachers	A 10-hour in-service teacher workshop held over 2 weeks Online discussion extended classroom interaction beyond FTF meetings.	A discussion forum was used for threaded discussion and a Facebook group for reflection. A WhatsApp group was used to remind participants to participate online.	Instructor encouraged divergent views and teachers' construction of their own knowledge Instructor found it challenging to synthesise the ideas discussed online and to link these to the FTF discussion.
Blended synchronous learning environment for a pre-service teacher course	A unique design which enables online and FTF classroom students to participate in class activities in real-time Students took turns to attend the online lessons	A two-way conferencing system to enable online students to attend the course when they were unable to travel to the class venue An online student was paired with a FTF student	Students appreciated the convenience of attending online lessons. However, online students found it difficult to get the instructor's attention, while FTF students found it unnatural to communicate with online members during group work.

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