Chapter 12
Teacher Learning Communities as Catalytic Levers for Educational Innovations in Singapore Schools

Azilawati Jamaludin, David Hung, Yancy Toh, and Imran Shaari

Abstract Grounded in our work on analysing teacher learning communities as they evolve from traditional learning epistemologies towards constructivist orientations and progressive, inquiry-driven pedagogies (Hung et al., J Interactive Learn Res 17:37–55, 2006; Hung et al., Educ Technol 55:20–26, 2015; Shaari et al., in press; Wu and Hung, Transforming learning, empowering learners: The international conference of the learning sciences (ICLS). International Society of the Learning Sciences, Singapore, vol 1, pp 474–481, 2016), this paper articulates teacher learning communities as catalytic levers for educational innovation in Singapore schools. We begin with an articulation of the characterizations of teacher learning communities within the Singapore education system—from those that organically emerge at the grassroots (teacher) level to those that were intentionally designed at the systems (ministry) level. While there has been growing recognition for networked learning of school faculties that engender results, which are meaningful and impactful at both the teacher and student level, the purported stance is that change towards innovation and progressive, inquiry-driven learning practices is not just a change in instructional strategies but also a fundamental change in teachers' epistemologies. Through case examples of the developmental processes of a networked learning community within the system, we posit that *apprenticeship-learning* affordances of networked learning communities underpin teachers' shifts in epistemology and function as proximal vehicles for catalyzing innovations through progressive, inquiry-driven pedagogies. These shifts are engendered through tenets of (i) growth intentionality, (ii) dialectics of structure-agency, design-emergence, periphery-centrality, and commonality-diversity, (iii) socio-technological leverages, and (iv) ecological coherence and alignments. Expanding our analysis both vertically (macro systems level to micro personal

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level) and horizontally (abstract cross-disciplines to concrete subject-specific affinities), we ground these theoretical ideas to a nuanced understanding of *scalable epistemic learning*, in the context of educational innovation and diffusion.

Keywords Inquiry based learning · Teacher learning communities · Teacher epistemology · Apprenticeship learning · Scalable epistemic learning · Innovation change · Networked learning communities

12.1 Introduction

Global challenges of accelerated human mobility, urban density, healthcare, and economic and environmental sustainability (IDA, 2015) have underscored how the old ways of twentieth-century education standardizations are ill suited to the fast, flexible, and vulnerable landscapes of the twenty-first century. Traditional models of education, rooted within assumptions of knowledge transfer from external sources—such as teachers, books, and schools—to students, categorized by age, progress, and amount of time spent in class, are struggling to engage a new generation of learners for whom learning is happening all the time—in formal and informal spaces, in classrooms and out of classrooms, and in online and offline environments. It is now more pertinent than ever to invest in the appropriate training and skills that will shape our learners' future, to attend to educational elements that seed deeper transformations in the quality of teaching and learning while fostering critical process skills embedded within inquiry-based practices. Such process skills, embedded within the twenty-first-century competencies framework (Fig. 12.1), include appropriate dispositions of questioning, knowledge building, problem solving, critical thinking, creativity and imagination, and aesthetics and design thinking, that are socially embedded, interest-driven and oriented towards development of personal integrity, social democracy, and the advancement of quality human living amidst networks of interactions.

Within the context of Singapore classrooms, there have been ongoing efforts towards reforming conventional didactic practices through innovative intervention projects spearheaded by the Office of Education Research (OER) at the National Institute of Education (NIE) (e.g. Social Studies inquiry (Critical Web Reader), knowledge building, seamless learning, productive failure, mathematics problem solving, game-based learning, six learning), albeit not without resonant tensions of education change in terms of resistance on the ground, innovation *wither* phenomena, and lack of sustained innovation cultivations (Hargreaves & Shirley, 2012). Within this vein, undergoing a basic change in pedagogical practices may be comparatively analogous to breaking down the 'Berlin Wall' of conventional didactic practices. From a macro-systemic perspective, if such a change can be optimally achieved, it is posited that it ought to be at *scale*. In other words when a change phenomenon begins to succeed, policy makers will begin to ask how the gains and benefits observed in a particular context can begin to spread. Specifically, it impels the question of how the spread can bear benefits across the system—not stratified to benefit only specific group (e.g. low, middle, high) of achievers or prejudiced on the part of students in faster-paced streams (Tan, 2013) and teachers towards students in slower-paced streams

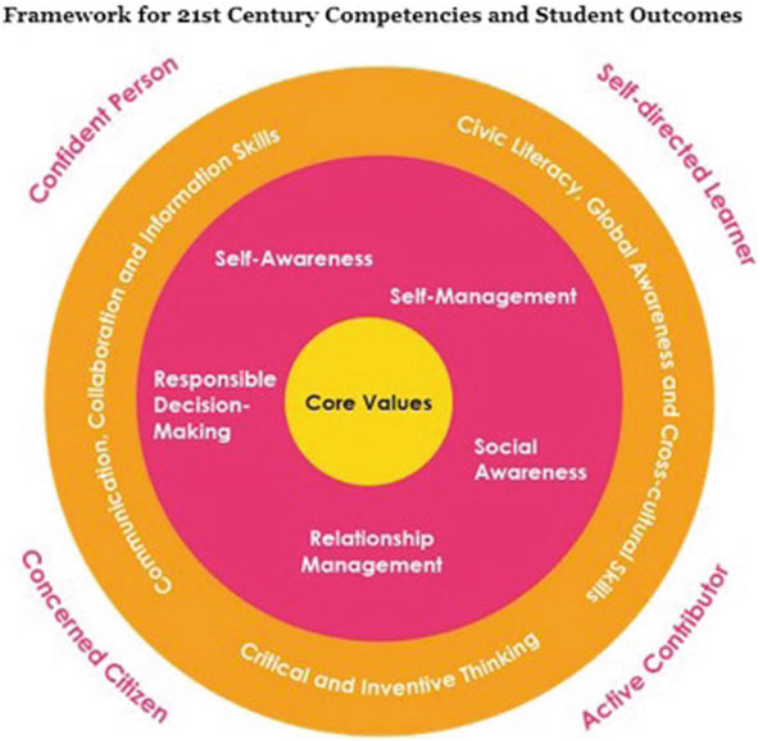

Fig. 12.1 Framework for twenty-first-century competencies (21st CC) by Ministry of Education, Singapore (MOE, 2017)

(see for e.g. Tan & Ho, 2001; Kang, 2004)—but instead how education change, that is systematically extensive across all levels and layers of learners, can achieve the critical mass to be sustainably engendered.

Our purported stance is that the shift from traditional knowledge transfer models towards innovation and progressive learning models is not just a change in instructional strategies, but a fundamental change in teachers' *epistemology*. This entails shifts in the way teachers' construe the process of learning and how knowledge is being constructed. While knowledge within a 'twentieth-century' paradigmatic thinking is described as fixed, stable and something that exists 'out there' waiting to be discovered, a progressive twenty-first-century lens views knowledge as fluid, complex, and uncertain and constructed in social contexts as people seek to make sense of their world. Teaching and learning in this paradigm are dominated by processes where knowledge is viewed as relational, a network or flow, and the aim is to use knowledge to make things happen (Gilbert, 2009). Sterling (2010) interprets a 'learning level, which may be said to be epistemic learning; that is, it involves a shift of epistemology or operative way of knowing and thinking that frames people's perception of, and interaction with, the world' (p. 23). This is consistent to Bateson's

(1972) view of 'seeing our worldview rather than seeing with our worldview so that we can be more open to and draw upon other views and possibilities' (p. 23). Within this vein, teachers need to change the way they view classroom learning from a dominantly teacher centric one to one which is student-centred. In other words, for education change and innovation towards inquiry-based learning practices to be sustained, it necessitates parallel shifts of teachers' and students' 'worldview' of the classroom and learning in general.

In this paper, we foreground a discussion of how scaling agentic inquiry practices, that underpin educational innovations, may be mediated—and catalyzed—through networked learning communities (nLCs). Specifically, we argue that scaling of innovative inquiry practices is not a mere 'top-down' roll out of resources related to any particular new pedagogy, nor is it adequate to provide only professional development for teachers; rather, it requires conviction on the part of teachers and the resilience for change seeded by the variant degrees of epistemic learning afforded by nLCs within the system, coupled with appropriate leadership and socio-technological infrastructures. In characterizing the variant types of nLCs within the Singapore education system, the research reported in this chapter seeks to (i) unpack how nLCs afford teacher's epistemic learning in the context of innovation scaling and diffusion and (ii) distil tenets of *scalable epistemic learning* for the teacher innovation change process.

12.2 Literature

12.2.1 Teachers' Epistemic Learning as Underpinning Change Towards Innovation and Inquiry-Driven Learning

Research on epistemic learning has primarily focused on the relation between the knower and the known (Hofer & Pintrich, 1997). Hofer (2004), for instance, posited plausible models of personal epistemology and describes two areas and four dimensions of beliefs about knowledge and knowing. This included two main lines of research on individual's beliefs that are most compatible to philosophical dimensions of epistemology: *nature of knowledge* and *nature of knowing*. Four dimensions were specified further from these two areas which included: certainty of knowledge (ranging from conceptions of knowledge being fixed to being tentative and evolving), relationality of knowledge (ranging from conceptions of knowledge as discrete pieces of information to highly interrelated concepts), source of knowledge (ranging from conceptions of knowledge being derived from external authorities to conceptions of self as knower), and justification for knowing (how knowledge claims are evaluated, including the use of evidence, the use they make of authority and expertise, and their evaluation of experts) (Hofer & Pintrich, 1997, p. 120). Other researchers have extended the area of epistemology into three broad categories of investigation that delved into analysis of epistemic learning (i) from a developmental perspective

(e.g. Perry, 1999; Belenky et al., 1986; Baxter Magolda, 1992; King & Kitchener, 1994; Kuhn, 1995), (ii) as a system of beliefs (e.g. Schommer-Aikins, 2002), and (iii) as conceptualizations of personal epistemology (e.g. diSessa et al., 2002; Hofer & Pintrich, 1997).

Specific to teaching and learning, contemporary psychological research on learners' epistemological conceptions may trace its roots back to the work of Perry (1968/1999), who interviewed Harvard students' ideas about knowledge during their four year college. Schommer's (1990) research into teachers' epistemological beliefs, on the other hand, surfaced the importance of relating both teachers' and learners' cognition and performance. Specifically, she developed a multidimensional framework of epistemological beliefs as consisting of knowledge interrelations (ranging from the belief that knowledge is isolated bits to the belief that knowledge is interrelated concepts), knowledge stability (ranging from the belief that knowledge is certain and unchanging to the belief that knowledge is tentative and evolving), knowledge source (ranging from the belief that knowledge comes from authority to the belief that knowledge comes from reason and empirical evidence), learning ability (ranging from the belief that ability to learn is gifted or innate at birth to the view that it can be increased), and learning velocity (ranging from the belief that learning takes place quickly or not at all to the belief that learning is gradual) (Schommer, 1990; Schommer et al., 1992). The theoretical assumption framing the development of the multidimensionality of beliefs was based on the premise that learners' epistemological beliefs range from 'naïve' towards 'sophisticated' beliefs (Schommer, 1998), wherein 'naïve' is used to indicate a person who thinks that knowledge is certain, absolute, and can be transferred by an authority; while sophisticated beliefs refer to knowledge that is more complex, relative, flexible, and can be actively constructed by the individual (Brownlee et al., 2001) (see Fig. 12.2). Howard et al., (2000) approximated such a naive-sophisticated categorization to align to the behaviouristic vis-a-vis constructivistic paradigm of knowledge and knowing. Extending this approximation, we posit that engendering innovative change towards inquiry-based paradigms within the classrooms would thus necessitate socially constructivist epistemic shifts towards more sophisticated cognizance of *knowledge* and *knowing* means, in terms of how both are inextricably intertwined and co-constructed through developmental

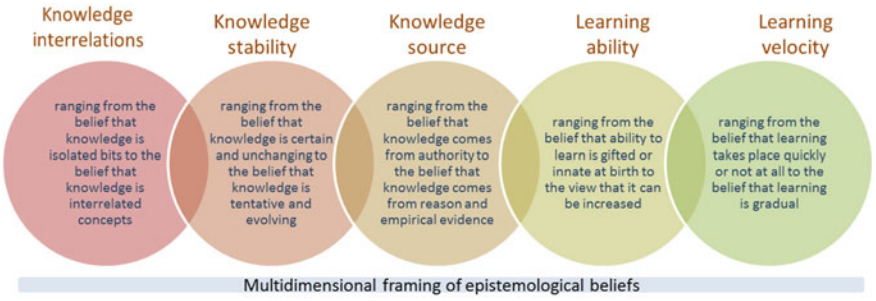

Fig. 12.2 Framework for epistemic learning on a range from *naïve* to *sophisticated*

trajectories of learner-directed inquiry—a process we frame as *epistemic learning* in this paper.

12.2.2 Challenges for Epistemic Learning and Innovation in the Singapore Classroom

Against a backdrop of securing economic competitiveness and social cohesion, while grappling with the challenges posed by globalization, the Singapore education system has evolved over the years through enunciations of the Desired Outcomes of Education (DoE) (MOE, 2015) for supporting clear and defensible learning foci for students, teachers, and leaders. The DoE documents (e.g. see Table 12.1) represented approaches by the Ministry of Education (MoE) to categorize outcomes specific to the various stages of schooling and had twofold functionality—first, as a common blueprint to guide all education policies and programmes, and, second, as a basis for evaluating the success of these policies and programmes (Tan, 2013).

Yet, amidst clear articulations of the DoE and the 21st CC framework (refer to Fig. 12.1), there exist an inherent problematization of the culture of didactic teaching

Table 12.1 Key stage outcomes of education

At the end of Primary school, students should:	At the end of Secondary school, students should:	At the end of Post- Secondary education, students should:
be able to distinguish right from wrong	have moral integrity	have moral courage to stand up for what is right
know their strengths and areas for growth	believe in their abilities and be able to adapt to change	be resilient in the face of adversity
be able to cooperate, share and care for others	be able to work in teams and show empathy for others	be able to collaborate across cultures and be socially responsible
have a lively curiosity about things	be creative and have an inquiring mind	be innovative and enterprising
be able to think for and express themselves confidently	be able to appreciate diverse views and communicate effectively	be able to think critically and communicate persuasively
take pride in their work	take responsibility for own learning	be purposeful in pursuit of excellence
have healthy habits and an awareness of the arts	enjoy physical activities and appreciate the arts	pursue a healthy lifestyle and have an appreciation for aesthetics
know and love Singapore	believe in Singapore and understand what matters to Singapore	be proud to be Singaporeans and understand Singapore in relation to the world

Ministry of Education (2015) (Printed with permission from MOE)

coupled with rote learning (Koh, 2013) endemic within a system characterized by competitive high-stakes national examinations (Tan, 2013) and a historical ideology of efficiency for the survival of the nation. For example, although students in Singapore have achieved first place in public and international Mathematics and Science Olympiads, such achievements have been attributed to the 'spoon-feeding' culture and "well-trained exam-smart" students' (Koh, 2013, p. 53). Antithesis to the illocutionary intent of the policies implemented to achieve the DoE (e.g. Thinking Schools, Learning Nation; Teach Less, Learn More, Curriculum 2015), anecdotal evidences suggest that teachers, parents, and students remain seemingly embroiled in a feverish quest for examination success. However, in our observations concerning schools, we recognize that the intents of DoE are gradually taking root, albeit rather gradually. Content teaching remains a priority within classrooms, and with a typical class size of 35 students, this makes innovation challenging with teachers having to both manage the classroom and to complete teaching the necessary syllabus in all the subject areas. As a result, frontal teaching is often defaulted, privileging seemingly naïve conceptions of knowledge construction. Yet Singaporean students excel in practically all international benchmark tests, which may suggest that the seemingly frontal pedagogy may have semblances of deep learning.

Reverberating tensions between examination assessments and DoE yield questions as to whether teachers can overcome this need to cover the content syllabus yet at the same time foster innovative learning. The aforementioned ongoing efforts at the OER, NIE has spanned almost a decade of active endeavours into seeding inquiry based approaches in schools through the various intervention projects, and the need is recognized to frame a systematic approach to how innovative, inquiry-based practices may be diffused into classrooms in an accelerated, equitable manner. For instance, there have been attempts to overcome the linearity of syllabus coverage through the introduction of more performative ways, consistent to real world enactments, of learning through game-based learning where content is not 'transmitted' through traditional ways, but through students' appropriating conceptual understanding through the gameplay experience (Chee & Tan, 2012). While such progressive ways of teaching and learning bear its own efficacies, the spread of such practices was impeded by systemic challenges inherent within the Singapore education system, induced by both practical constraints such as time and assessment requirements as well as skills and epistemic limitations. These include challenges such as teachers' 'locked' mindset where they hold steadfast to content transmission and syllabus completion during classroom enactments; constrained time where teachers have limited time for professional development and sharing of good practices and students have no time and space for reflection; and exam-oriented culture where learning is oriented to drill and practices assessment. Importantly, against a backdrop of such scaling and translation challenges, we observed the important role of leadership and socio-technological enablers for inquiry driven learning (Toh et al., 2014). For example, in another intervention project on students' synchronous questioning (Wu, 2018), the technological platform—SMILE, a low-cost, LAN-based technology—mitigated the problem of asynchronous questioning in traditional classrooms by affording synchronous interactions and questions. Over the course of time,

one can begin to see whether other peers 'liked' the questions that their peers ask. This apparently prompted the impetus for more questions posed and seeding the change in classrooms culture—from one of mere 'receiving' to that of active 'questioning'. As students' dispositional shifts in terms of questioning and gainful learning were made visible, teachers become more convinced of the efficacy of the intervention and seeds the changes in thinking and practices in schools.

From a research perspective, orienteering towards the need for intervening and scaling inquiry-based practices thus triggers the following questions—First, what are the key elements in the innovation that enable that change in practice, vis-à-vis the current modes of instruction as practised in schools? Second, what are the affordances in that innovation that facilitates epistemic inquiry; and third, how do we know that we have achieved the desired learning outcomes of education?

12.3 Method

12.3.1 Network Learning Communities as the Contextual Space of Analysis

Against this backdrop, the research reported in this paper arises from our work in analysing how mentoring or apprenticeship forms of learning occur among teachers at the various layers of the ecology, and the observable shifts in teachers' epistemic learning as they engaged within the respective communities. To analyse and interpret our data, a case study approach (Yin, 2002) was used in conjunction with qualitative interview and discourse analytic methods. Given the socially constructivist underpinnings of this study, relevant methods of inquiry within such a paradigm are represented by qualitative methods of 'understanding meanings people have constructed, that is, how they make sense of the world and the experiences they have in the world' (Merriam, 1998, p. 6). This relates closely to our research objectives of understanding how change towards inquiry-based paradigms within the classrooms may be engendered and scaled, afforded through nLCs. A social constructivist-driven epistemology thus necessitates interaction and dialog between researchers and participants, in this case participating teachers of the nLCs, in uncovering a multitude of perspectives and insights into the meaning making processes. Specific to our study, our research methods entail qualitative measures in the form of face-to-face interviews and open-ended dialog, (Trochim, 2001) with a view to articulating teachers' evolving interactions as they make meaning in the context of socially networked communities.

Addressing our first research question, we first sought to characterize the variant types of nLCs within the Singapore education system. Next, through an analytical case example of teacher engagement in a networked learning community—a digital game-based learning community (DGBLC) that focuses on developing teachers' competencies in the context of scaling the pedagogical understandings of digital

game-based learning in schools, we illustrate the degree of shifts observed in teachers' epistemic learning. At an overarching level, the networked learning community is oriented towards seeding the aforementioned innovative inquiry practices pertinent in the current context of teaching and learning through *epistemic learning*. For example, the DGBLC's focus is to explore how teachers can harness on collective knowledge and experiences in using digital games for students' learning and for teachers to strategically seed inquiry practices into their lesson design and classroom implementation. Importantly, we posit that fostering a culture of inquiry fundamentally stems from teachers' epistemic learning, and it is when these learning shifts occur that scaling in the context of maximal latitude of education change is achieved.

12.4 Findings and Discussion

12.4.1 Networked Learning Communities (nLCs) for Epistemic Learning

Moving away from non-innovative classroom cultures, where teachers in isolation tend to develop cultures of 'conservatism, individualism, and "presentism"—a fixation on the short term' (Hargreaves & Shirley, 2012, p. 91), there have been systemic efforts within the Singapore educational context to engage teachers in collaborative cultures that both underscores teacher development and student outcomes oriented towards future needed skills. Specifically, such collaborative efforts were strongly focused on (i) the relation between individual: structured mentoring, (ii) professional learning communities in schools, and (iii) networked learning communities and subject chapter communities at the national or cluster school level (Heng, 2014). From an overarching perspective, it is observed that the origin point of the nLCs can be traced to the respective ecological layers of the system through initial structures to bring teachers together and through an emergent recognition of 'need' that revolves around students' learning (Fig. 12.3).

At the micro-level, individual school and teacher-led nLCs are emerged from the 'micro'-realms of classroom teacher and student interactions for operationalization and enactment of classroom-based activities. We observed these include specific on-the-ground needs from teachers such as 'how to differentiate inquiry lessons in the classroom such that all students can be levelled up', 'how to use inquiry for lower ability learners', and 'how do we motivate [students] to pose questions when time is tight and they are more keen to know specific content'. At the meso-level, nLCs function as intermediaries of networking and partnerships between clusters of schools[1] or affinity-led collaborations drawn upon institutional pedagogical

[1] Schools in Singapore are organized into geographical zonal branches based on North, South, East, and West proximal locations. Within each geographical zonal branch, schools were further organized into clusters (approximately 7–8 clusters per zone), with an average of 11–13 schools per cluster (a mix of primary, secondary, and post-secondary institutions). With a view to raising the capacity of the

Fig. 12.3 Characterization of macro-meso-micro-nLCs within the system

orientations or organizing structures to share knowledge and develop cross-school strategies in advancing inquiry-based pedagogies. These include schools within the same cluster coming together to share resources and support each other through, for example, concrete lesson redesign of primary science lessons for inquiry enactments. Teacher expertise is also shared through such meso-level collaborations. At the macro-level, nLCs are 'system-led' designed from divisions within the ministry, such as the Academy of Singapore Teachers (AST) and Educational Technology Divisions (ETD). Aligned to broad policy thrusts, system-led nLCs draw upon global trends and landscape developments, and these include recognizing the need to systematically level up the principles of professionalism in terms of teachers' status and competencies to address students' learning challenges of the twenty-first century. For example, ETD-led communities focus on levelling up teachers' tinkering and experimentative dispositions through spreading practices adapted from innovations seeded in Future Schools.[2] Specifically, premised on the conjecture that inquiry-based practices are 'process inclined' and shifting epistemologies of teachers would enable the diffusion of inquiry-based practices, and we observed that the variant nLCs are existing within dialectics of design and emergence at the macro-meso-micro-layers for the learning and spread of inquiry-based practices. Concomitantly, beyond

leadership teams and the level of performance in each school, a cluster superintendent was attached to every cluster to facilitate networking, sharing and collaboration among the member schools within the cluster (Ministry of Education, 2015). Each school zonal branch further oversees the management of the schools within their purview, in terms of personnel development and facilitating projects and activities oriented towards overarching desired outcomes of education.

[2] Future Schools in Singapore are distinguished by their capacity to leverage infocomm technologies and innovative school designs to enable efficient administrative practices and innovative school-wide educational programmes to bring about engaged learning for students.

functioning as catalytic growth mechanisms for teachers' epistemic learning toward innovative pedagogies, there is a gradated apprenticeship structure afforded by the different nLCs where teachers' change process may be outlined on an acquisition to transformation continuum, as unpacked by the following case illustration.

12.4.2 Case Illustration: Digital-Game-Based Learning Community

An example of a 'macro-level' nLC that focuses on leveraging learning affordances of digital games to meet desired pedagogical outcomes is the digital game-based learning community (DGBLC). Formed at the 'systems' level by the Ministry of Education-Educational Technology Division (MOE-ETD), the DGBLC explored how teachers can harness on collective knowledge and experiences in using digital games for students' learning and for teachers to strategically implement these understandings into their lesson design and classroom implementation. Facilitated by ETD officers, the DGBLC function to provide concrete participatory contexts for teachers to not only appropriate understandings about digital games in relation to pedagogy but also to (i) gain embodied experiences of designing their own games through game design workshops (e.g. Scratch), (ii) peer-evaluate community members' created games, (iii) have shared access to a common repository of member created games, (iv) garner access to networking opportunities with game enthusiasts, and (v) leverage on support by the DGBL community.

Importantly, at an overarching level, the DGBLC provides opportunities for teachers' professional growth and epistemic learning (within the domain of DGBL) through the explicit identification of DGBL 'teacher champions', who are meant to take on the role of facilitators as ETD officers move on to a 'sponsor' level of participation, and seeds continual interaction between community members, mediated through both synchronous, mediated by an online Coursemology platform, and asynchronous (e.g. thematically designed face to face workshops) means. Figure 12.4 provides an illustrative description of the annual growth trajectory of the DGBLC (across four school terms).

12.5 DGBLC as a 'Vehicle' for Innovation Diffusion

A key thrust for seeding learning communities such as the DGBLC was premised on an orientation towards the diffusion of innovations as arising from MOE-ETD

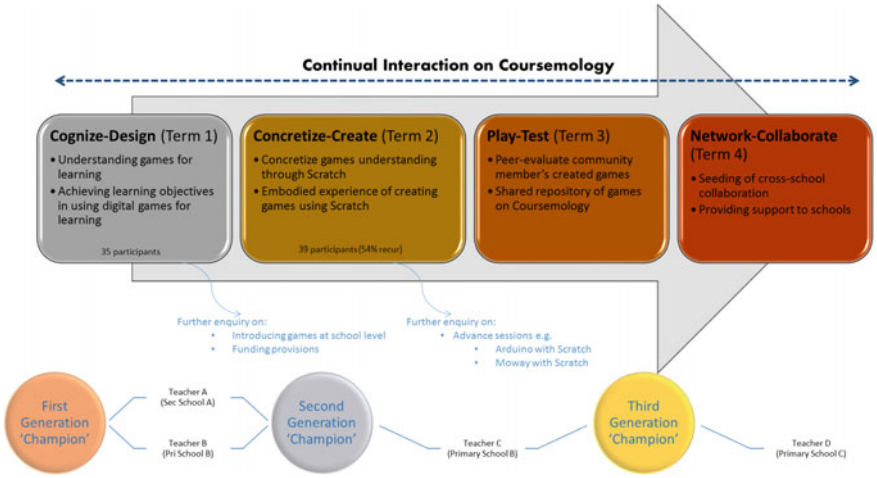

Fig. 12.4 Growth trajectory of the DGBLC is oriented towards teachers' professional growth and the seeding of teacher champions

projects such as the Future Schools(FS)[3] or eduLab[4] projects. An initial FS innovation highlighted at the DGBLC was the canberraLive and 3DHive, developed by an FS primary school in Singapore, underpinned by play as pedagogy. Arising from the concrete 'need' of a macro-landscape shift towards exponential growth of digital game-based tools, the DGBLC similarly evolved to foreground it's focus on emphasizing pedagogical approaches and ICT-enabled practices, rather than specific technological tools. For example, while participating teachers within the DGBLC were taken through a hands-on experience in creating games using Scratch, it is only but one of many other game creation platforms that teachers could potentially try their hands on Similarly, 'gaming interests' among the participating teachers vary. For example, there was participation variance in terms of a group of teachers who prefer to conduct paper prototypes through adaptation of existing off-the-shelf games, a group who prefers freemium Web-based/mobile application games, and a group who prefer to design their own simple games through visual programming languages such as Scratch, Kodu, Alice, or Tynker. As shared by a teacher on her participation within the DGBLC,

> …in my classrooms, I've been using some games for the students…those games that are available on the Marshall Cavendish portal….and I can see that in terms of engagement,

[3] The FutureSchools@Singapore programme was conceptualized in 2007. Selected schools are chosen to be ICT pathfinders, by engaging in experimentation and exploration with ICT for learning, developing innovative tools for sound pedagogical use. These Future Schools developed innovations are then taken up by the respective LCs for further innovation spread and diffusion practices to other schools within the system.

[4] eduLab was launched in 2012 to foster ideation and experimentation with educational technology. It also provides the structural supports to facilitate technology experimentation for schools and teachers.

> they are definitely more engaged than normal lessons…so I'm here to learn more about game-based design and learning…about how I can do it better for my students…more than just engagement…so the first time here, we learnt about the design principles, today I'm doing hands-on game creation…a good experience for me—Anne, Primary School Teacher

12.5.1 Scale Adaptations

Within this vein, while the DGBLC is oriented towards levelling up teacher competencies with respect to the innovation, the degrees of abstraction afforded by decoupling generic pedagogical principles of digital game-based learning inadvertently seed the need for teachers to recontextualize DGBL innovations within their own context of use. In other words, the 'scale' that DGBLC orients towards is not rooted within the spread of a tangible innovation, rather it is situated within the adaptations and recontextualization that teachers' engage in as they appropriate fundamental understandings of why and how to implement DGBL in their respective classrooms. Such an approach is observed to be more amenable to sustainability of ground-up innovations vis-a-vis top-down innovation 'roll-outs' to schools wherein the latter may initially be embraced but often wither from the lack of sustained cultivation (e.g. Carnine, 1997; Clark, 1989; Cohen et al., 2007; Elmore, 1996; Greenwood & Abbot, 2001; Kozma, 2000; King-Sears, 2001; Sannino, 2010).

12.5.2 Seed Teacher Champions

Concomitantly, it is also observed that seeding the growth of teacher leaders (champions) to sustain DGBL innovations within and across schools, afforded by the participatory structures of the DGBLC, serves to reinforce the socio-technological infrastructure necessary for innovations to take root over time. For instance, the facilitation of the DGBLC face-to-face workshops were underpinned by an intentional design of identifying teacher champions or enthusiasts who are able to co-conduct the workshops either through sharing of experiences or expertise in relation to their DGBL implementations. As reflected in Fig. 12.4, there was a 'generational' (e.g. first generation, second generation, etc.) growth of champions to provide the multiple levels of leadership (in terms of expertise and experience) in nurturing the community. For identified DGBLC champions, they were invited to co-chart the courses of the workshops they will be facilitating, providing more varied sharing as well as support to other 'novice' members within the community, while the ETD officers provide learning directions and professional development for these teacher champions.

12.5.3 Shifts from Periphery to Core

Although the DGBLC was helmed by the ETOs, the devolvement of control to identified teacher champions paved the trajectory for teachers to move from being members of DGBLC at the legitimate peripheries (Lave & Wenger, 1991) to being core members of the community as they establish more in-depth relations with ETOs and gained competence and legitimacy, to conduct workshops. For example, Fig. 12.5 depicts a secondary school science teacher who may be categorized as one of the generational champions within the DGBLC. In Fig. 12.5, the teacher, Mr. E, is seen conducting a games assessment topic, as part of sharing his experience and expertise in having implemented DGBL in his classrooms. Through his dialogical interactions via the DGBLC online platforms and his interactions with the ETOs, Mr. E was invited to co-facilitate the Term1 workshop, framed by a common vision and shared affinity for DGBL to enhance students' learning.

Within the Coursemology platform, the ETOs and teacher champions were also instrumental in enculturating peripheral members 'up to speed' through structured, pre-convening discussion threads. For instance, there are specific threads on the online platform that enthused peripheral members to introduce themselves and specific topics of interest set up to further engage members in dialogical interactions (see Fig. 12.6 for sample core member-led discussions).

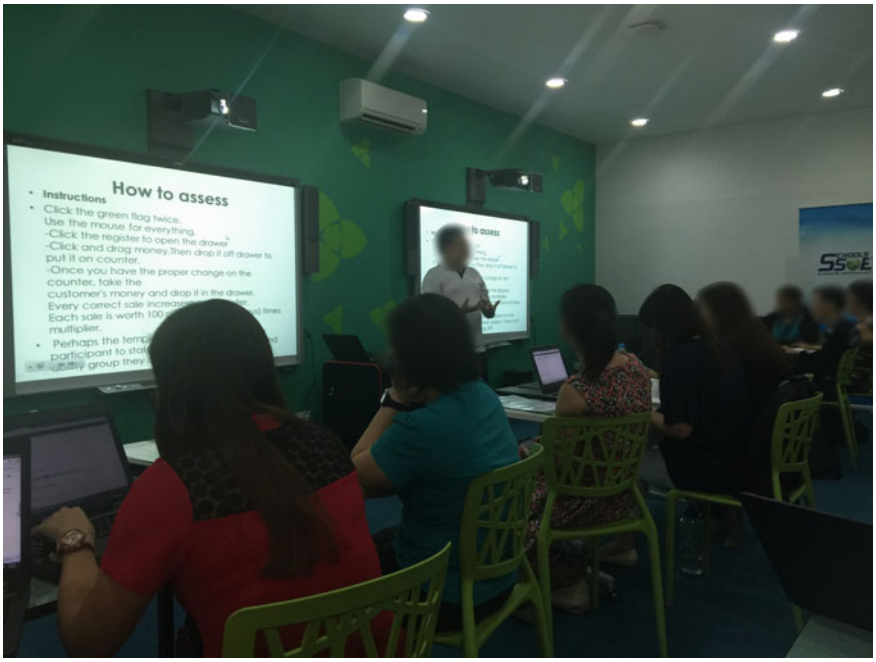

Fig. 12.5 Core 'generational' teacher champion of the DGBLC facilitating a face-to-face workshop

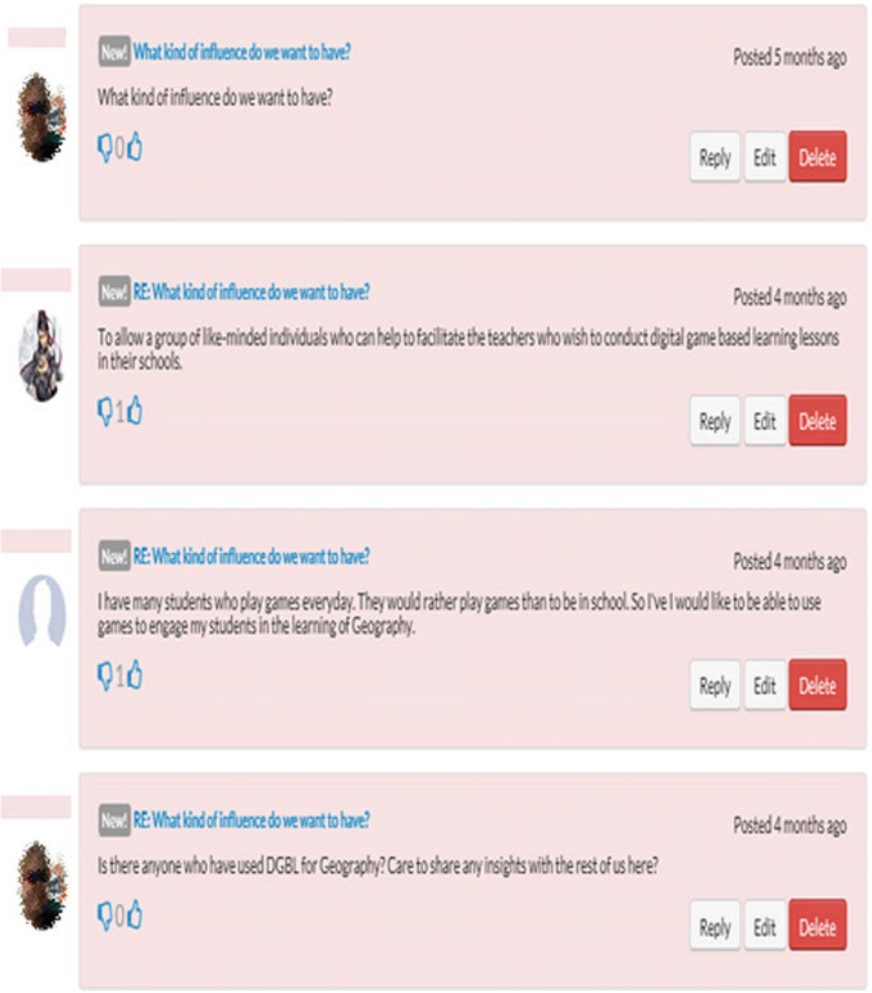

Fig. 12.6 Example of 'core member' led discussions and enculturating threads for peripheral members

12.5.4 Dialectics of 'Convergence–Divergence', 'Takeways-Givebacks'

The autonomy given to Mr. E to co-conduct the workshop, yet framed by a common overarching vision of the objectives of the DGBLC highlights the importance of a convergence–divergence dialectics at play. While there was divergence in terms of the topics related to DGBL that teacher champions could introduce to the community (e.g. conceptual understandings of games, hand-on experimentation of Scratch), the

ETOs ensured some form of convergence on common overarching narratives. Specifically, there was an explicit promoting of a narrative of 'teacher learning for student learning' that the ETOs held on fast to as they designed for sustained teacher participation through a developmental trajectory of growth. Teacher participation was not just restricted to face-to-face or online workshops but also through 'home assignments' where they were expected to continue working on their game creations (e.g., from Workshop 2). The created games, in turn, were added as repository resources for sharing within the community. In this sense, a tacit accountability measure was put in place in that, the activities of the community were not just positioned as 'takeaways' but so too required teachers' to 'give back' *meaningfully* towards the community. Observably, such structures of 'convergence–divergence' and 'takeaways-givebacks' facilitated the community's value for the purpose it was meant to serve, that is, not as a static assemblage, but rather as a process-oriented learning community, that targets continual evolvement and relevance of the DGBLC.

12.5.5 Leveraging on the 'Ecology' and Socio-technological Affordances

In a continual endeavour to meet teachers' needs, the DGBLC has a structured process in place to ensure its relevance. For instance, ensuing every face-to-face session, a request form will be emailed out to all participating teachers to allow them to request for support with respect to digital game-based implementations within their respective schools. Within this support request, the ETOs can avail themselves to go down to schools to provide further assistance to the teachers. The ETOs were proactive in continually gathering feedback from the teachers as part of a macro-'needs analysis' orientation to ensure that activities of the DGBLC remain relevant and more importantly, meaningful, for the teachers. There was also an overt leverage on the wider community of DGBLC practitioners, such as engaging game-based researchers from NIE or international game researchers, to conduct sharing and co-evaluate workshop assignments with the ETOs. The intentional design of 'feeding' the community with 'outside' expertise to mitigate 'inward focusness' was aligned with broader 'system thinking' mindsets that underpin epistemologies of digital games research.

Additionally, as part of recognizing teachers' contributions towards the DGBLC, contributions, such as workshop facilitations, were also made known to the wider 'ecology'. In other words, teacher 'givebacks' to the community was recognized through communication to their relevant school personnel or principals. Teachers' development was also made visible through the use of 'Leaderboard' on Coursemology to capture their achievement levels and ongoing participation analysis. The Coursemology platform was also harnessed upon to provide embodied learning experiences for the teachers to understand the process of gamification and draw out differences between gamification and game-based learning.

12.5.6 *Building Relations Through Commonality and Diversity*

At a fundamental level, the DGBLC sought to attain teachers' buy-in towards the pedagogical principles and adaptations of DGBLC through attuning to teachers' needs and constantly ensuring meaningfulness of the community activities. Through positioning the uptake of DGBLC as sharing a 'common struggle', the diversity of problems that teacher member surfaces (e.g. technical issues, assessment issues) propels '*teacher learning for student learning*' through threads of commonality (common struggle of implementing DGBL for students' learning) and diversity (every teacher faces different problems, shared with the community). Continual engagement efforts such as online training activities scheduled fortnightly within the Coursemology platform as a means to keep members up-to-date with the latest international developments in DGBL were also put in place. These sustainability-oriented efforts represent incremental steps towards engendering positive teacher relations that seed the base for sustaining teachers' interest and engagement within the community. However, in a recourse towards the acquisition-transformation teacher change process, whether these *acquired* practices translated into iterative percolations of *transformative classroom practices* oriented towards inquiry-pedagogies and reduced inequities remain tentative.

12.6 Framing of Innovation Scale Through the Lens of nLCs

The variance in how learning communities define and enact their practices and growth trajectory varies from one community to another. For DGBLC, observably, their enactments in the context of innovation diffusion are correlated to the *teacher capacity building* thrust posited from the onset. Conceptually, this may be approximated to a framing of innovation diffusion where appropriate structures need to be set up for an interactional and engagement process to encourage teachers to experiment with DGBL-resonant approaches in their respective disciplines.

These experimentations in turn are seeded within an expanded socio-cultural peer/group/ learning community context, oriented towards strengthening professional learning to increase educator effectiveness and, ultimately, attain the desired students learning outcomes. We propose that the efficacies of progressive nLCS may be approximated by tenets of *scalable* epistemic apprenticeship, as observed through

- Iterative proximal handholding
  - Senior/more experienced teachers apprenticizes less experienced teachers who would then handhold other new teachers and guide the planning, guide the design, help to execute lessons
  - The handholding process is iterated through first and second level 'champions'

- Peer-to-peer role modelling/support
  - Open classrooms, first-hand insights into what is happening in the classroom, videos, snippets of videos of what is happening in the classroom (or outside); frame to frame video scaffolding on how to enact a lesson, how to follow up, etc.
- Visible students artefacts/developmental trajectory
  - Provide a more 'concrete' reality of what an envisaged classroom looks like/ought to aim for
  - Show visible expressions of what happens in the classrooms through students' artefacts such as journaling and peer feedback.
- Mitigating tensions, finding alignments
  - Tensions between transferability of 21st CC process skills vis-a-vis assessment demands.

12.6.1 School Leadership Support for Teachers to Be in nLCs

Being responsible to every child and ensuring they do well in the assessments is a very real concern for teachers, and these are very legitimate concerns of a teacher in a classroom. Moreover, schools are not giving up on the high levels of performance in all the major high stakes national assessments in the Singapore context. In other words, how do we achieve both academic performances and inquiry based learning at the same time; how do teachers become adaptive to both performances?

Thus, we realized that getting the teacher prepared in doing these innovations, facilitating for the school principal to support, and to find the resources to do the 'out of the ordinary' endeavour for this period of time is very key. We realized that without school support, very few teachers can actually engage in this endeavour. The dialectics of structure and agency remains critical. It is about putting in place 'designed structures' that gives time off for the teacher to engage in a new endeavour, while providing the latitudinal space for teacher's agency in terms of their adaptations and recontextualization of practices relevant for their learners within the space of emergence. Concomitantly 'designing' for a peer support group in enacting the innovations is necessary. In other words, how can leadership support enable these curricular adaptations as there is a need to change the assumptions of the curricula to enact this new scheme of work? How do we create the support group for the teacher in the classroom to learn together with other peers; and how would this process change the teacher's way of thinking. These are issues that are very critical for us.

To illustrate, these are some voices of principals:

> Teachers need to change the ways they teach and yet meet the curricular objectives. So if we have the end in mind, how do we work backwards although not taking the same road

> as in the past? It's not a simple substitution or replacement exercise to develop 21st century skills; there is a need to go back to the goals. We need to create a sustaining culture where teachers are comfortable, otherwise it won't work. We need professional development that builds not just the competencies but the culture in doing it. (Principal A)
>
> Why not we open up these classrooms so that the next layer of teachers who want to do this intervention can start observing first. Why don't we open up classrooms – then I told her, we should, yeah let's open it up! So if you come from the principle [of what we intend to do], we know that there's hope, you see. (Principal B)

Once we understood a core kernel and theory that has emerged from an innovation, and facilitated by good examples, we can design purposively to make them public (or visible) so that all teachers can see it. By situating these good cases into existing nLCs, these resources are intentionally factored into the workflow of teachers' busy time schedules for learning.

Teachers in Singapore schools generally would not use technology in their classroom practices if they do not see the practical *need* for using it. If in the co-design and redesign of lessons, they can rationally recognize how the affordances (e.g., freezing time and motion in simulations and helping students to observe phenomena by slowing it down) enable learning, they would be willing to do it. This experience hinges upon the shifts within the dimensions of their epistemic beliefs towards knowledge and knowing. Structuring for teachers to work together and to reflect on their practices including recognizing them for these efforts are critical. When teachers witness their students understanding concepts better as afforded by these technologies, they usually are willing to undergo the change process. They begin to realize that engaging learners from a non-didactic perspective really works better even in the milieu of high stakes performance needs.

Concomitantly with the need for strong school leadership support, teacher facilitators of nLCs also play a critical role. One important characteristic is to let members in the nLC have a voice. The culture to be borne in nLCs must be open according to the leader facilitators we interviewed. More generically, these leaders tell us that they encourage members of nLCs to have a voice and every view is important, with the intent to let discussions flow. This orientation is particular critical in an East-Asian culture where participants are typically shy with voicing in public. School leaders' support in paving the way for their teachers to partake in nLC activities and to play a leading role in these communities is also crucial.

12.7 Conclusion

We need to grow the capacity of teachers with respect to epistemic learning in Singapore, if we want to advance the Singapore education system with respect to inquiry-based learning. Teachers need to understand why something would work because if they do not understand why, adaptations might go lethal. We also need to create the social-infrastructure that enables teachers to undergo the epistemic change process.

Along these lines, how can we create networks of learning across schools since expertise in inquiry-based learning is better found beyond individual schools presently. How can apprenticeship forms of scaffolding and learning occur among teachers in nLCs. Dialogue in nLCs alone is insufficient to shift epistemologies. Teachers need to go through this journey of change from acquisition to actual embodied learning process and towards transformation. Peer support from fellow nLC members, and school leaders' encouragement and facilitating of the conditions for change in schools are crucial tenets, for successful trajectories of development at both teacher and classroom levels, as illustrated in Fig. 12.7.

In Fig. 12.7, NLCs are described as the communities initiated by MOE; nLCs are those formed by schools and clusters, and PLCs are initiated from within schools. These three kinds of networked learning communities should complement each other from a system's perspective. Moreover, according to Fig. 12.7, we differentiate between teacher-led needs vis-à-vis system initiated ones—i.e. designed needs. From the case study documented in this chapter, designed needs are not uncommon in the Singapore context. Designed needs speak to the issue that there are teachers who have gained traction insofar as the innovation is concerned and that there is no need to start from 'ground zero', implying that teachers can leverage upon existing communities to participate in the endeavours. Teacher needs include professional and performative needs, while designed needs assume that teachers may have involuntary stances in the participation within these nLCs. Hence, in such situations, there is a further need to enculturate teachers to be enthused about these designed innovations.

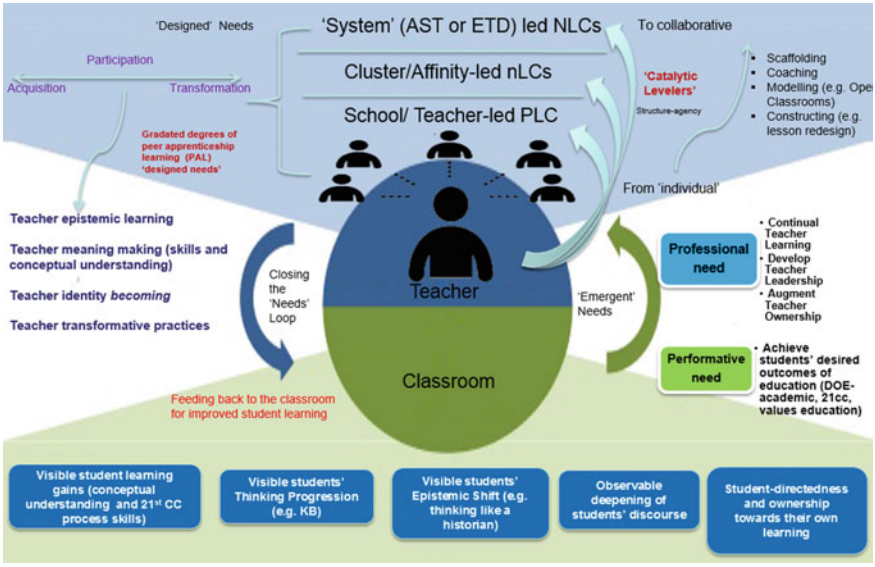

Fig. 12.7 Tenets of change at the teacher and classroom level afforded by networked learning

Within this vein, we recognize that scaling up of inquiry-based learning, which we have concomitantly argued as a teacher change in epistemology, cannot be overly hastened. It takes more than perceived cultural changes. The journey towards innovation is also a change in the larger macro, meso, and micro-ecosystem—the challenge is not just teachers but also the larger ecology—the expectations of parents and other related stakeholders. Change is thus inadvertently complex with multi-dimension and multi-layered entailments, but the journey remains necessary for our continual endeavour in developing the best for our learners to thrive in the world that is coming.

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