

Complex Interaction Between Technology, Pedagogy and Content Knowledge: A Case Study in Chinese Language Classroom

Yancy TOH^{a*}, Lung-Hsiang, WONG & Ching-Sing CHAI^b,
Jenny Yen Lin LEE^c & Jessy Pui Shiong NG^c

^a Learning Sciences Laboratory, National Institute of Education, Singapore

^b Learning Sciences and Technology Academic Group, National Institute of Education, Singapore

^c Nan Chiau Primary School, Ministry of Education, Singapore

*yancy.toh@nie.edu.sg

Abstract: Technological Pedagogical Content Knowledge (TPACK) has been used as a conceptual framework for understanding how teachers harness various domains of knowledge for technology integration. Guided by the research goal of discerning how a teacher's ICT integration effort can co-evolve with interactions between *technology*, *pedagogy* and *content* knowledge, we examine, in this paper, a Chinese language teacher's evolving TPACK on *seamless learning* (continuity of learning moments across locations, time, technologies and social settings) via the complexity constructs of *distribution*, *enaction* and *emergence*. Complexity theory is employed as it foregrounds the interconnectedness of constituents in a learning ecology, paralleling the philosophy that the three TPACK knowledge bases should be studied in totality. The research questions are: (a) How was the knowledge of seamless language learning distributed in the process of knowledge creation? (b) How was the integration of technological, pedagogical and content knowledge enacted during the seamless language lessons? (c) What emerged as a result of the complex interactions between technological, pedagogical and content knowledge? Data is drawn from interview transcripts, student artefacts, meeting minutes, lesson plans as well as fieldnotes collected over two years' of lesson observations and professional development sessions. Our analysis attenuates two findings that are underplayed in the TPACK literature on language learning: 1) the integration of formal and informal learning activities, which can be enhanced by affordances of technological platforms, is pivotal for encouraging output (artefacts); 2) building a participatory culture offers students more opportunities for sustained and self-organised peer learning. The paper concludes with the discussion on the pedagogical implications of findings and future directions for research.

Keywords: complexity theory, TPACK, emergence, seamless learning, ICT integration

1. Introduction

Technological Pedagogical Content Knowledge (TPACK) has been used as a conceptual framework for understanding how teachers synthesise the different knowledge bases when integrating technology for teaching and learning. Originating from Shulman's (1986) work on Pedagogical Content Knowledge (PCK), Thompson and Mishra (2007) position TPACK as the dynamic interdependence of the three knowledge areas. Recognising their intertwining nature, Koehler and Mishra (2008) contend that it is difficult to compartmentalise the three components in teacher's practice. To examine such interconnectedness between the knowledge domains, we propose foregrounding the use of complexity theory-informed principles of *distribution*, *enaction* and *emergence* to complement TPACK's framework. Chai, Koh and Tsai (2013) have highlighted the importance of such juxtaposition of theoretical frameworks between TPACK and other frameworks to deepen TPACK. In addition, given that TPACK are in essence knowledge that emerged from the complex interplay between teachers' knowledge and their perception of the environment, the complex theory perspective is likely to be a suitable framework to unpack how TPACK are formulated and enacted by teachers. The proposed

hybrid theoretical lenses will be used to analyse a case study that arose from our two-year school-based study of MyCLOUD (My Chinese Language ubiquitous learning Days) (Wong, Chai, Chin, Hsieh, & Liu, 2012). We hope to operationalise the qualitative study of teachers' emerging TPACK by looking specifically at: 1) how decisions regarding the use of technology is distributed across resources, processes or learning spaces; 2) how teachers enact and improvise technology-enhanced lessons and how this enaction influence their TPACK; 3) the emergence of proficiencies, cultures or new practices as a result of using technology in Chinese language learning classrooms. Our purpose is to provide empirical evidence on how teacher's ICT integration efforts can co-evolve with the on-going interactions between technology, pedagogy and content.

2. Literature Review and Theoretical Underpinnings

2.1 *Seamless Learning and Seamless Language Learning*

The notion of seamless learning was first espoused by Chan et al. (2006). It is a form of technological-pedagogical knowledge that leveraged on the affordances of mobile computing to enable the use of 1:1 (one-device-per-student), 24x7 (24 hours a day, 7 days a week) mobile devices for seamless learning. Seamless learning occurs when a person experiences continuity in learning moments, and consciously bridges the multifaceted learning efforts across a combination of locations, times, technologies or social settings (adapted from: Sharples, et al., 2012, p. 24). Initially construed without specific reference to content knowledge, seamless learning can be adapted for language learning, culminating in the notion of *Seamless Language Learning* (SLL) that foregrounds the on-going technology-mediated process of language learning across different learning spaces, thereby helping language learners to connect the linguistic inputs and outputs through meaningful contexts.

2.2 *Complexity Perspective*

The central tenet of complexity perspective is that in a complex system, one cannot isolate any factor as all constituents in a system may "compound each other's effects in ways that both increase and diminish their aggregate influence" (Mason, 2008, p45). Changes in one component would therefore have ramifications throughout the system. Similarly, for learning, Sumara and Davis (1997) contend that "there is no direct causal, linear and fixable relationships" and "all contributing factors in any teaching or learning situation are intricately and complexly related" (p. 414). In language learning, Syverson (2008) also sees literacy development as a function of complex adaptive systems where individuals, groups and cultures have influence on literacy practices that can only be studied as a whole. Echoing this view is Walsh (2008) who feels that reading and writing cannot be separated from students' environment which is now interlaced with new media, proffering opportunities for "reading, writing, viewing, listening and responding simultaneously" (p101). The use of complexity lens can therefore transcend the dichotomy between individual and socio-cultural views of second language learning as it considers the holistic processes and relationships which learners are embedded in.

To look at the inter-dependence of subsystems in a complex language learning situation, we adopted three of Syverson's (2008) complexity constructs: distribution, enaction and emergence. Distribution refers to how cognition can be distributed beyond the body to be shared across a myriad of constituents such as "individuals, tools and environmental factors" (Nelson, 2011, p97). Enaction refers to the practices or activities through which relationships, flows and connections manifest in the form of knowledge that is subjected to on-going changes, situated in specific environments or larger social spheres (Nelson, 2011; Syverson, 2008). Emergence happens when "new structures, activities, texts and thoughts arise out of the self-organising of agents" (Nelson, 2011, p96-97). We believe that the three constructs will aptly illuminate the multi-level influences that affect teacher's TPACK as the nested influences can be studied through iterative feedback loops at the sub-system levels of: (a) knowledge distribution; evident from the interplay of university-school partnerships, teacher's holding technological-pedagogical-content knowledge, students' language knowledge and affordances of learning resources residing with the platform; (b) teacher's enaction, which can be studied through the

inter-dependence of her TPACK and (c) emergence of new knowledge, studied through teacher's reified TPACK and student's emergent usage of Chinese language.

2.3 TPACK

Synthesising from the literature reviewed (Chai et al., 2013; Mishra & Koehler, 2006), the seven constructs of TPACK are defined as follow: (1) technological knowledge (TK) refers to knowledge about the use ICT hardware, software and associated peripherals; (2) pedagogical knowledge (PK) emphasises knowledge about students' learning, instructional methods, learning theories, and assessment to teach a subject matter without references to content; (3) content knowledge (CK) encapsulates subject matter without consideration about teaching it; (4) pedagogical content knowledge (PCK) is the knowledge of representing content knowledge and adopting pedagogical strategies to make the specific content/topic more understandable for the learners; (5) technological pedagogical knowledge (TPK) delves into the knowledge of existence and specifications of various technologies to enable teaching approaches without reference towards subject matter; (6) technological content knowledge (TCK) focuses on how to use technology to represent, research and create the content in different ways without consideration about teaching and (7) technological pedagogical content knowledge (TPACK) is the holistic consideration of using various technologies to teach, represent and/or facilitate knowledge creation of specific subject content. Chai et al.'s (2013) review of TPACK indicates that while there are hundreds of studies using the TPACK framework, qualitative studies targeted at language learning are few. The authors also contend that the conception of TPACK can be made more explicit by articulating the contextual factors influencing its development. We concur and in this paper, we will be foregrounding the use of complexity theory to unpack how teacher's technological-pedagogical-content knowledge can be activated by ecological factors which will influence the emergence of technological integration skills in Chinese language classroom.

3. Method

3.1 Context

3.1.1 Context of Language Learning in Singapore

In Singapore, all teaching subjects are taught in English except for the mother tongues. English Language has become the preferred day-to-day language among the younger generation. There is increasing evidence that Chinese Language teachers are facing greater challenges in engaging students to learn Chinese; and that students' Chinese Language proficiency level has been declining (Ong, 2002). In addition, Chinese language instruction is predominantly teacher-centred and decontextualised (Liu, Goh, & Zhang, 2006). As such, there is a need for researchers and practitioners to explore and develop alternative pedagogies that promote a self-directed and participatory culture of learning that is deeply rooted in socio-constructivism.

3.1.2 Context of School and Project

The experimental school is a neighbourhood primary school that has carved a niche in the use of 1:1 computing for student-centred learning across all levels. MyCLOUD is one of the projects conducted in the school through school-university partnership. An instantiation of SLL, MyCLOUD aims to develop a scalable mobile- and cloud-computing-assisted Chinese Language learning environment. It includes the articulation of the learning design framework and the employment of a technological platform which encompasses the following functions: digital voice-over text passages, student-generated mobile dictionary (known as 'Mictionary'), social networking space, discussion forum and essay writing function. Every student was equipped with an Acer Iconia slate (tablet) with camera function and a 3G data plan. The students used the slates primarily for data collection, artefact creation and online interactions from Primary 3 to 4 (3rd-4th grade). A typical classroom lesson include students taking photos based on contextual needs, making sentences and publishing them on

the social portal for sharing and critiquing. The engagement level of students was predicated on whether they were enculturated in carrying out extended authentic language learning activities after school.

3.1.3 Profile of Participating Teacher

Three teachers with different profiles participated in MyCLOUD intervention. None of them received formal training about TPACK. As we want to achieve depth rather than breadth in terms of articulating the interconnection of TPACK knowledge bases, we only include the case study of one experimental teacher, Serene, in this paper as she has the highest level of self-agency and her mixed-achievement experimental class displayed the highest level of engagement. Serene was invited to participate in this project as she had many years of experience in championing school-based research, working alongside university researchers over three different projects that spanned five years. Known for her high level of enthusiasm and creativity, she was able to motivate students in the projects she had spearheaded and was thus highly regarded by the department as one of the trailblazers. She used to be a graphics designer and did not enter the teaching profession with high proficiency in Chinese Literature. However, she was very confident about her pedagogical and technological knowledge, as well as her ability to inter-mesh the three knowledge bases.

3.2 Data Sources and Analysis

To further our research interests, we analysed a range of qualitative data comprising interview transcripts (mid-intervention and post-intervention), student artefacts, meeting minutes, lesson plans as well as fieldnotes from lesson observation and professional development sessions. We focused more on qualitative data as we are examining a complex phenomenon that is irreducible to individual components, thus rendering the quantitative causal explanation ineffectual. Episodes that pointed to her knowledge on technology, pedagogy and content were singled out and their inter-relationship studied. Using the complexity constructs of distribution, enaction and emergence as our organising structure to report our findings, we were guided by the following framing questions to aid our analysis: (a) How was the knowledge of seamless language learning distributed in the process of knowledge creation? (b) How was the integration of technological, pedagogical and content knowledge enacted during the seamless language lessons? (c) What emerged as a result of the complex interactions between technological, pedagogical and content knowledge?

4. Findings

4.1 Distribution

This vignette is an exposition of how Serene's TPACK was shaped by multiple mutually-constituting influences. Evidence was drawn from her devised lesson plans, enacted lessons and interview transcripts. In this section, we report the findings on how knowledge and practices of seamless language learning were distributed in the process of knowledge co-construction between teachers, researchers, learners and technology.

4.1.1 Knowledge Distribution Between Serene and Researchers

Collaborative lesson design was the means for the team to formulate the classroom learning practices. A typical co-design cycle comprised six stages: (1) researchers suggested and negotiated the design guidelines for lesson plans with the teachers; (2) teachers provided first draft of the lesson plans; (3) researchers provided feedback on the draft; (4) teachers and researchers collectively refined the lesson plans; (5) teachers enacted the lessons and (6) teachers and researchers made further changes to the lesson plans or design guidelines. The researchers shared their theoretical understandings while the teachers contributed knowledge about the environment and the students. Mutual respect empowered the teachers and the researchers to create TPACK for SLL. The team's collective expertise was

synthesized through collective negotiation and crystallised in the form of broad pedagogical objectives. As the predominant knowledge broker, Serene had the liberty to further customise the lesson activities. Examples include selectively incorporating researcher-recommended pedagogical strategies that most aptly meshed with the content of textbook passage as well as counter-proposing and simplifying the criteria of researcher-devised rubrics so that they could be more easily understood by her students (Meeting minutes\20120716).

Similarly, Serene's lesson plan was also being modified iteratively by the actors involved. Researchers deliberated on whether the learning objectives of the lessons were specific and measurable; whether the learning activities were inter-connected and whether the evaluation of students' progress was present. In the instance that these features were oblique, the researchers would recommend strategies such as using the framework of 5W1H (Who-What-When-Where-Why-How) to help students develop, re-write and narrate the text passage. (Lesson plan\2012\Lesson 7). The iterative process was also an exposition of distributed cognition where the intellectual inputs of various actors shaped each others' mental models about teaching and learning.

4.1.2 Knowledge Distribution Between Serene, Researchers and Students

At the classroom level, there was also participatory democracy. The most representative example was the incorporation of students' idea to conduct interview and posting interview content online as learning activities, triggered by their mutual appreciation of the recording functions of the slate. Although a review of lesson plan and post-lesson observation suggested that the activities and goals were diffused and disjointed, the students were apparently highly engaged in the activities. Serene explained the merits of such practice:

Allow the students to think. You can learn a lot from the students.....Students can provide many perspectives and suggestions. I asked what they think they would learn and the activities we can conduct. When they brought up ideas, I would let them know that I would consider adopting them. When I really incorporated their ideas, they would feel extremely proud. (post-intervention interview\co-construction\20120508)

Serene gave students opportunities to express what was meaningful to them and allowed them to determine their learning goals, suggesting the presence of a participatory learning ecology.

In addition, due to researchers' advocacy of emphasising more on linguistic output before input of knowledge, she delayed the rectification of mistakes so as to empower students to partake in peer evaluation/critiquing. Misconceptions were surfaced and rectified through class discussion. This revolutionised the traditional notion of language teaching where input took higher precedence before output (Pica, 1994). These meaning-making engagements not only enhanced students' self-directed learning and collaborative learning competencies, they were also aligned with the spirit of constructivism, departing from the traditional mode of relying on memorisation for language acquisition. Recognising active contributors' efforts towards building a buoyant online community, she invited those students to be platform moderators. The vivacious peer exchanges then motivated other students to use the platform on a sustained basis.

4.1.3 Role of Technology in Distributing Knowledge

Technology also played a vital role in terms of enriching the content of language learning, manifested in the creation of artefact across temporal and spatial dimensions. Students spontaneously documented interesting episodes that happened during and after school hours. Serene created a virtuous loop when she consciously merged such distributed resources into the classroom for consolidation or discussion. Technology afforded students and teacher a common platform to create content from their lenses which became teaching resources in classrooms. They exchanged views on peripheral but pertinent issues related to the content of textbook. In one of the lessons on "Watching Television", Serene asked students to share on the social networking site the television programmes they liked to watch. These resources became lead-in content to the main body of textbook passage (Meeting minutes\20120714). Her use of Mictionary also served as a "launch pad" for consolidating new vocabularies. As the technology allows tagging, it enabled teachers and students to structure the content. The module also

allowed students to find out the pronunciation and explanations of the vocabularies. Thus, these embedded technologies allowed students to be more self-directed. This was made possible as part of the epistemic authority about content knowledge was re-distributed and the incidence of teacher's direct transmission practices reduced due to the affordances inherent in the abovementioned technological probes.

4.2 Enaction

This section reports on the how the integration of technological, pedagogical and content knowledge was customised during the enaction of seamless language lessons. For enaction, we looked specifically at how Serene displayed her situational intelligence as well as improvised learning material.

4.2.1 Circumventing Technological Constraints In-Situ

After implementing the online environment, Serene was quick to point out the technological constraints of the portal and found ways to work around them. One limitation of the portal was that students were unable to upload or sequence photos/images in a consecutive manner to be used as a storyboard for essay writing. Being a resourceful champion, Serene taught students how to create photo collage on PowerPoint instead, which could be subsequently uploaded to the portal as a single object. She also used PowerPoint appropriately as visual cues; scaffolding aids for group discussion; props for role-play activities and time management tool for monitoring class activities. The activation of TK (use of Powerpoint) to overcome technological constraints to fulfil pedagogical need of creating storyboard (PK) for essay writing (CK) is an act of creating TPACK. Serene also displayed situational intelligence by proposing the use of alternative technology when conventional technology failed. To illustrate, when students could not share their artefacts with group members through MyCLOUD platform, she would combine the use of another portal or ask students to create free email accounts for the purpose of disseminating photos to group mates during fieldtrips (Lesson plan\20120217; Meeting minutes\Reflections on fieldtrip\20111115). Reflexively, her acts informed the university researchers on how the system needs to be improved.

4.2.2 Integrating and Customising the Use of Technology

Beyond what was discussed in the co-designed lesson plan, Serene integrated multimedia technologies to accentuate the content of the text. As an example, in one of the lessons that revolved around learning language through drama and role-play, she was able to embed sound clips and images in PowerPoint to re-create the different scenes depicted in the textbook passages. (Fieldnotes\Lesson 7\20120912).

Whilst many Chinese teachers perceived the school-subscribed textbook-complementing Flash animation package as an effective multimedia representation of textbook content, Serene seldom used the package in her lessons. She rationalised:

The flash animation is just digitised text and some students have already subscribed to it and can view them at home anytime. It wasn't very different from the physical textbook. If I do use it, I only play the animated segments. Moreover, in MyCLOUD portal, there is also a module on digitised text, so there is no need to spend precious time duplicating the activity. I would rather spend the time on other interesting activities that students can partake so that they can really understand the content of textbook and the contextual use of topical vocabularies. (post-intervention interview\content representation\20120508)

Serene's TPACK was exemplified here as she articulated how choices regarding content representation were made. Her pedagogical focus was on students' interest and active learning. As she perceived that the use of the animation package did not add much value in terms of helping students understand the content of textbook better, she designed other pedagogical activities to utilise the additional time freed from opting out of the above activity.

4.2.3 Aligning the Use of Technology with School and Pedagogical Goals

Enactment is also influenced by contextual factor such as the school and project's emphasis on bridging formal and informal learning. Serene was able to leverage on serendipitous learning moments to achieve this blending. One prominent example was Serene's attempt to upload a photo collage that described how a bird that accidentally flew into her office was subsequently freed. She then associated the moral of the story with the textbook passage of "Life Liberation of Fish": She explained:

When the bird flew into the staff room, even if this was not within our job scope,...I tried to link this incident with the ninth topic on "Life Liberation of Fish". When the two contexts were synergised, students will understand the meaning of the text passage. (post-intervention interview\opportunistic learning\20120508)

After her online trigger, the students responded with enthusiasm, making comments about the physical appearance of bird and exercising moral reasoning to see if it was ethical to free the bird in the manner displayed in the picture collage. Serene would spend time outside curriculum hours to review the work and provide an array of online feedback, ranging from correcting grammar, helping students to expand content or socialising with them. The distribution of ideas among teacher, researchers and students mentioned in the preceding section also affected Serene's subsequent lesson design. As she incorporated ideas in a spontaneous manner, her lessons were perpetually a work-in-progress, unfolding through the moment-by-moment instructional decisions.

Whilst the above incident shows how Serene brought informal context into formal lessons, she also made deliberate efforts to design activities so that the context from formal curriculum can spillover to students' informal learning context. For example, "Growing Green Bean" is the last passage of Primary Three's textbook and as part of extended activity, Serene asked students to grow green beans at home, record their observation and document their observed changes on MyCLOUD platform. Students went beyond factual description and described how they felt as they observed their green beans over time. All these evidence suggest strongly that her teaching practices were emergent and aligned with the project's philosophy of forging the continuity of students' learning moments in a just-in-time fashion. MyCLOUD had thus provided an overarching framework for Serene to re-think about her pedagogical practices, thus manifesting the spirit of seamless language learning. We further articulate the construct of emergence in the next section.

4.3 Emergence

In this section, we are interested in examining how new structures, texts, thoughts, culture, practices or proficiencies arise out of the self-organising acts of agents.

4.3.1 Emergence of New Pedagogical Strategies

For Serene, her exploration and experimentation with new teaching approaches culminated in an expanded repertoire of pedagogical strategies, especially in terms of allowing students to do self-exploration before her intervention. She described:

I usually ask them (students) to make preparations prior to lesson, so that it will be easier when I go through the textbook passage. Sometimes, I will also single out some vocabularies, but instead of teaching them, I asked them to find out the meaning themselves and take photos that best exemplified the meanings of vocabularies. (post-intervention interview\pedagogical strategies\20120508)

Here, she articulated her ease of incorporating the new philosophy of emphasising output before input, a pedagogical strategy which she had not employed before the intervention. However, her expansion of the abovementioned TPACK did not come without internal struggle, especially in relation to the pedagogical practice of delayed validation. Said Serene:

Researchers have recommended that I do not correct students' mistakes on the spot. I have to withhold validation. It was not easy for me as I was worried students' misconceptions would be entrenched. I waited and waited, not knowing when is a good time to intervene. I did try to facilitate without correcting directly. At first, I corrected mistakes in a direct manner, worrying that I will neglect or miss out some mistakes if I don't have time to revisit. (post-intervention interview\delayed validation\20120508)

The above explicated the fact that Serene's TPACK was influenced by researchers' pedagogical framework on language learning. Experiencing pedagogical dissonance in the beginning, she eventually tried this pedagogical approach. Although Serene saw instances of peer learning but she felt that the success was contingent on the competency of students. Most students were not able to go beyond pointing out wrong words. Towards the end of the intervention, she had the following insight:

I felt that the consolidation (of students' artefacts and misconceptions) could be done better. For MyCLOUD, consolidation is of utmost importance. We must reinforce and bolster the correct usage of vocabularies. (post-intervention interview\delayed validation\20120508)

Of equal importance to consolidation is the integration of learning design. Serene's ability to integrate the use of MyCLOUD into the current curriculum beyond the prescribed intervention hours constituted another aspect of her prominent growth. She integrated many mobilised lessons due to the positive feedback loop received from students regarding the learning activities and her own initiative to use technology to bridge formal and informal learning during in-class facilitation. Her previous projects used technology as an add-on but this project required its routine use. She understood the importance of positioning Chinese language as a living language that had to be integrated into students' daily life and actively fostered the bridging of formal and informal learning. She encouraged students to bring their slates to school twice a week and gave formative feedback when going through students' artefacts in class. Her phenomenal success in this area could perhaps be due to the bi-directional influence of both her prior TPACK as well as iterative and reified TPACK after embarking on the intervention. In her previous projects, she also worked relentlessly to foster the informal use of Chinese idioms during out-of-class contexts, albeit using smartphones instead of slates. These embedded tacit TPACK was transferrable to her current project, apparent from how she scaffolded current students using past examples of student artefacts. She also nourished herself by constantly drawing insights from educational websites:

I will find time to surf the net and look at how language lessons are conducted in other countries. I will input "creative teaching" first, and then narrow down to the scope of "language".....some are related to mobile learning. Also, I continue to use the successful methods that I adopted in the previous projects I have participated in. (post-intervention interview\source of inspiration\20120508)

Serene would then implement viable ideas in class, driven by the intention to use technology for inciting motivation. Her pedagogical strategies were coalesced around this objective.

4.3.2 Emergence of New Classroom Culture and Higher Self-efficacy

Due to Serene's enculturation efforts, there was a critical mass of students who had developed the habit of micro-blogging about their lives. The class artefacts were heterogeneous and online exchanges vivacious. Highly positive about the impact of MyCLOUD project on her students' language learning, Serene illustrated how the intervention had transformed two of her students, both in terms of building self esteem and improving their borderline results significantly. Ted, who initially disliked Chinese, advanced from Band 3 (50-69 marks) to Band 2 (70-84 marks). He wrote on the portal:

In the past, I dislike Chinese. MyCLOUD helped me improve a lot. Last year, I performed poorly for Chinese and would have failed if I scored one or two points less. The examination paper was

very difficult. But now, I find the Chinese examination a breeze and could complete within half an hour. I visit the portal every other day.....I love Fridays as I will get to take photos outside classroom and make sentences. I like to share my posts and look forward to receiving classmates' reply. (artefact\20121103)

Another student, Shane, used to be an introvert and a victim of bullying in his lower primary days. He discovered new-found confidence through expressing himself online. He scored 39 marks in his first Chinese examination in Primary Three, but managed to pass the subject by the second year of intervention. He attributed his improvement to his intensive engagement on MyCLOUD portal. In particular, he felt the Mictionary and essay sharing modules had supported and enhanced his vocabulary acquisition efforts (artefact\121102).

4.3.3 Emergence of Technological Competencies

Another emergent competency that we observed was that students' technological literacy skills had improved. Serene noted that the students counter-proposed to her about creating their own artefacts when she asked them to find ready images related to Singapore history from Google (post-intervention interview\prosumers\20120508). This suggests that students had become "prosumers" (Tapscott & Williams, 2008) who were able to "consume" information and use technology to "produce" artefacts to illustrate the context of their constructed sentence.

Synthesising the three lenses, we see that the distribution of ideas, resources and learning spaces can synergistically and dynamically shape the enaction of Serene's lesson and inevitably lead to the emergence of new culture and practices. To iterate succinctly, the distribution of ideas among teacher, students and researchers led to the in-situ enaction of Serene's lessons as well as the emergence of a new participatory class culture and the reification of Serene's TPACK. We discuss the implications in the next section.

5. Discussion and Future Research Directions

In the preceding sections, we have labouriously outlined the evidence that demonstrated Serene's TPACK. Serene's success was partly fuelled by her devotion, creativity, risk-taking attitude and fierce determination to ensure the intervention worked. Her prior TPACK before intervention both shaped and was shaped by her enactment of new instructional methods, forming discursive processes and feedback loops. Apart from her personal traits, Serene's success in integrating technology can also be attributed to the following: (1) She leveraged on her prior TPACK accumulated over years of championing many research-based ICT projects which saw her effectively scaffolding students on creating contextually-rich artefacts; (2) She actively forged the connection between formal language learning and informal daily life happenings by "walking the talk", posting interesting photos of her overseas trip and making comments about students' posts, frequently flavoured with tinge of her humour. Her prior success in similar projects (see: Wong, 2013; Wong, Chen, Chai, Chin, & Gao, 2011; Wong, Chin, Tan, & Liu, 2010) also fuelled her conviction about the value of bridging formal-informal learning which saw her exercising her tacit knowledge in this project; (3) Serene's active facilitation sparked off children's enthusiasm, resulting in *self-organised* online exchanges and reporting similar to photo-journaling. The learning environment became a constant flux of interactions that had a life of its own which lasted way beyond the end of the intervention cycle. This *self-sustained interest* in communication suggested that the portal had become an embodied part of students' life. (4) Serene also encouraged distributed decision-making in terms of lesson planning, which highly engaged her students who were eager to contribute ideas.

What pedagogical implications does this vignette have on language learning and technology integration? While we cannot make generalisations or causal attributions about the effect of intervention on students' academic results in this paper, we can put forward the proposition that Singapore students' motivation to learn Chinese will most likely be improved if the teacher could help them cultivate the sustained habit of engaging in free writing, coupled with the pedagogical strategy of building up a participatory and prosumer culture to perpetuate their self-organised interests. Learning environments such as MyCLOUD can support these endeavours where students can create artefacts

on-the-go and publish their work instantaneously. As long as the culture of co-creation and sharing was established, students would be willing to extend the usage of language beyond classroom hours and experience the benefits of socio-constructivism as the spirit of community became more palpable.

We would also like to reiterate that by stressing on “self-organisation”, we do not mean no intervention is needed. Instead of using top-down approach as the term “intervention” is commonly understood, intervention when located within the complexity paradigm takes shape in the form of culture building. Like what Serene did, she initially enculturated the students and established the conducive conditions for interaction and thereafter, allowed things to unfold over the course of time. She intervened not to control what was written online, but to provide stimulus for further exchanges. There was “bounded instability” as she was guided by the overarching objective of creating a seamless learning experience for students while at the same time tolerated chaos. Her intervention was indirect and faded into the background once the use of portal became integrated into students’ life.

At the point of writing, we have scaled up the use of MyCLOUD learning package to all Primary 3 classes in this year and had started the professional development sessions for affiliated schools which will be embarking on this model next year. What we would like to continue to pursue is to track the TPACK of the new participating teachers at the beginning, mid and end cycle of intervention and see how their changing TPACK affects lesson enactment. As the teachers came from schools with different technological profiles, the implementation of MyCLOUD in a wide variety of conditions will help us enhance the robustness of intervention design and thus address the limitations of findings based on a single case study. This can potentially inform both research and practice on how to equip language teachers with critical TPACK to help them integrate technology seamlessly in classes.

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