The purpose of this paper is to propose a sociocultural approach in the integration of ICT into the classroom. A sociocultural perspective, using the cultural historical activity theory as proposed by Engeström (1987), describes how ICT has been integrated into the classrooms of a primary school in Singapore which has been designated a Future School. This paper highlights the importance of the sociocultural context where ICT is being situated. It also attempts to find out the elements within this sociocultural context that would have a significant impact on the integration of ICT into teaching and learning. From the activity-theoretical perspective, the contradictions that emerge from integrating ICT into the classrooms are discussed and how the illumination of these contradictions could lead to an expansive form of learning.

Factors Influencing ICT Integration in the Classroom

Recent research studies have also highlighted the importance of contextual factors in facilitating and influencing the use of ICT for teaching and learning in the classrooms. Tondeur, Devos, Houtte, Braak, and Valcke (2009) argued that school characteristics affect educational change such as ICT integration. Both structural (i.e., infrastructure, planning and support) and cultural (i.e., leadership, being goal-oriented and innovative) school characteristics contribute to ICT integration in the classroom. They added that “[a] mere focus on teacher characteristics could lead to ‘individual blame’ rather than ‘system blame’ when focusing on explaining variables related to limited ICT integration. Previous research often ignored the systemic nature of ICT integration, including the role of school characteristics” (Tondeur, Devos, Houtte, Braak, & Valcke, p. 224). The authors also argued that educational improvement or innovation efforts should consider, to a large extent, the power of site or place.

In another study, Drent and Meeлиssen (2008) reported that most of the research on the implementation of ICT in schools focused on factors that influence the use of ICT in general. These studies often assume using ICT will lead to changes in teaching arrangements and teaching methods without explicitly analysing the factors that influence innovative ICT use. The research literature on the implementation of ICT in general shows that it involves a large number of influencing factors (e.g., Hew & Brush, 2007; Tay, Lim & Lim, 2010; Tay, Nair & Lim, 2010). Research has also shown that factors which pertain to both the school and its teachers are interrelated and the success of implementing ICT is not dependent on the availability or absence of one individual factor. If anything, its successful implementation is determined by a dynamic process involving a set of interrelated factors.

Khalid, Nawawi and Roslan (2009) used the eight conditions that facilitate the implementation of education technology innovations, as suggested by Ely (1999), for their quantitative survey study with teachers on the conditions that have influenced the use of ICT in secondary schools in their country. The authors reported that only three out of the eight conditions are present in their findings and these are: (1) commitment by those involved, (2) leadership, and (3) presence of knowledge and skills. The other five conditions such as rewards or incentives, availability of resources, dissatisfaction with the status quo, participation and time are present but to a lesser degree in the school. When the presence of all eight conditions are high, there is a higher likelihood that educational innovation will be implemented and sustained (Ely, 1999). Although the conditions are presented independently, they are interrelated.

Cultural Historical Activity Theory

Lim (2002) argues for a more holistic approach of studying ICT in schools by adopting a sociocultural perspective. He proposes that “research studies in ICT need to shift their attention towards the whole configuration of events, activities, contents, and interpersonal processes taking place in the context that ICT is used. Such studies are particularly critical to educational research where the object of its inquiry is not simply knowledge, but useable knowledge” (p. 411) to the practitioners. He added that “[h]uman activity is socially bound; an individual never acts directly on his/her environment but rather, the activity that is undertaken by the individual to achieve the object of the environment is mediated by cultural means or reacts directly to his/her environment but rather, the activity that is undertaken by the individual to achieve the object of the environment is mediated by cultural means and tools, and the dynamic nature of the activity” (Lim, 2007, p. 87).

In addition, Lim (2007, p. 87) suggests that activity theory could be used as the theoretical framework to provide insights into the ICT integration process in Singapore schools. He argues that activity theory...
1. provides a conceptual map to the major loci among which human cognition is distributed in the learning environment, with ICT as one of the mediating tools;

2. includes other people who must be taken into account simultaneously with the subject as constituents of the activity system;

3. proposes that activities are driven by something more robust and enduring than an individual goal-directed activity; and

4. considers the history and development of the ICT integration process.

The increasing interest towards activity theory in education can be determined from the increasingly frequent citations to the term “activity theory” and to Yrjö Engeström’s 1987 article “Learning by Expanding” (Roth, 2004). Many current concerns regarding educational theory, particularly those related to computers, can be discussed using activity theory, which offers a flexible framework that addresses the dynamic and complex nature of educational interactions (Gilbert, 1999).

Engeström (2001) stresses the importance of explicit identification of the contradictions in the activity system, which helps practitioners focus their efforts on the root causes of the problems and the possibility of expansive transformations in an activity system. Contradictions are perceived as sources of change and development. Contradictions are not the same as conflicts or problems—they are historically accumulating structural tensions within and between activity systems. As activities are open systems, the adoption of a new element often leads to contradictions with other elements within the system itself. The introduction of a new tool causes a ‘disruption’ and can have a substantial impact upon the transformation of actions and operations (Waycott, Jones & Scanlon, 2005). Such contradictions create disturbances and conflicts, but could also be opportunities for innovative changes and potentially new developments.

In this paper, the activity theory is used to illustrate the importance of the context where the use of ICT for teaching and learning is situated. In addition, the contradictions are illuminated and its subsequent expansive learning are also highlighted and discussed.

**Observations Over the Past Three Years of Implementation—2008 to 2010**

Figure 1 illustrates the various components influencing the integration of ICT into the curriculum from the activity-theoretical perspective, and the observations made with triangulation formed between the dealings with the staff of the school, students, student-produced artefacts, the school’s achievements, records from the school and feedback from external visitors. The tools, rules, community, division of labour, subjects, object and outcome are briefly described in the following section.

**The Tools**

A wide range of technological tools were used to integrate ICT into teaching and learning. In terms of hardware, the school started implementing its one-to-one computing efforts from 2008, when it opened its door to its first cohort of Primary 1 students. Each classroom was equipped with an interactive whiteboard and two LC projectors.
During the initial months in 2008, the Tablet PCs were stored in wooden mobile storage and charging units. Each unit could only house six Tablet PCs (see Figure 2).

![Figure 2. First-generation mobile storage and charging unit (Maximum capacity of 6 Tablet PCs).](image)

The mobile storage and charging units were initially shared among the eight Primary 1 classes. A wireless internet environment was also set up in the classrooms to further support the one-to-one effort. As initial usage numbers of the Tablet PCs was encouraging, the school subsequently equipped all Primary 2 and 3 classes with Tablet PCs at a one-to-one ratio, and two-to-one ratio for the Primary 1 classes. Efforts were also put in to the redesign of earlier versions of the mobile storage unit. A more functional mobile storage unit, with a bigger storage capacity to house 20 Tablet PCs per unit with charging capability, was co-developed with the industry partner (see Figure 3).

![Figure 3. Fourth-generation mobile storage and charging unit (Maximum capacity of 20 Tablet PCs).](image)

In terms of software, the students use word processing and presentation software to create their digital stories. From the observations we made of the digital stories produced by the students from the various levels (Primary 1 to 3), it was evident that students used the word processing and presentation software as an alternative writing and construction tool to express their ideas and thoughts. Other than using the software as a writing tool, students inserted digital images taken during their learning journeys outside school and from the internet, added colour and design to it, and embedded their digitally recorded voice into their own digital stories. The school also subscribed to online digital story reading and comprehension websites for all of its students to provide them with further exposure to a rich array of online educational resources. Cloud computing was also used for the students to store and save their work into the online virtual drive. Blogs were set up by the Mathematics and Science teachers to upload resources and provide links to educational games sites for their teaching and learning needs. The students were able to learn with the computers when they construct their digital stories (see Jonassen, 2000 for more details with regard to learning with computers) as well as through the online resource websites.
The Rules

There are rules, procedures and accepted practices in the school setting. However, certain rules and conventional practices were modified to better support the whole school approach towards the integration of ICT into the curriculum. The more significant changes to the rules, procedures, and practices were:

1. The setting up of the educational research department to promote practitioner research. All the teaching staff are practitioner researchers that do research and look into their own teaching practices in greater depth, especially in the use of ICT for teaching and learning. Teaching staff chose topics of their interest and formed groups to evaluate and reflect on their practices and epistemologies.

2. Students not only submitted their works in conventional modes but also in digital formats which were accepted by their teachers.

3. Instead of using computing devices and tools at the computer laboratories, Tablet PCs were deployed to the respective classrooms. Hence, there was no longer a need for students to physically move to the computer laboratories when they needed to use the computers.

4. The school is presently engaging the parents of the pioneer cohort (Primary 3, 2010) to go on a one-to-one computer ownership scheme for the students in the coming year (i.e., 2011) so that they can use the computers in school as well as at home. Currently, the computers belong to the school and can only be used within the school compound.

The Community

The school community consists of the parents, school administrators, teachers, non-academic staff, the Ministry of Education (MOE), Infocom Development Authority (IDA), the National Research Foundation (NRF), institutes of higher learning (IHL) and industry partners. The FutureSchools@Singapore programme is a joint project between MOE and IDA. Officers from both agencies have worked with the school since December 2006 during the planning phase of making the school a Future School-enabled one. Parents who sent their children to the school have been open and supportive to the use of ICT for teaching and learning, and the pioneer batches of teachers who joined the school since it started are generally very passionate about using ICT for education. Expectations from the community about turning the school into a Future School that leverages on ICT for its teaching and learning is very clear. The school is also supported by the IHL in terms of its educational research efforts and the industry partners through the development of its online applications for teaching and learning.

Division of Labour

The school took a whole-school approach towards the integration of ICT into the curriculum, and the division of labour allowed the various stakeholders to play a part in the process. Staff from the various academic departments developed their curriculum and purposefully integrated the use of ICT into the school’s teaching and learning processes. The teachers adopted pedagogical approaches which required students to both learn with and from the computers. For instance, students can create their own digital stories (learning with) and learn reading comprehension (learning from) from the online storybooks and reading comprehension websites. Meanwhile, the technical team looks into setting up the whole-school wireless network, storage and charging of the Tablet PCs, projectors and interactive whiteboard in the classrooms, as well as providing other technical and logistical support. The school also set up the future committee to look into and explore emerging technologies. The school also received additional support from officers from the MOE and IDA.

The Subjects

The subjects of the activity system include the school administrators, teachers, technical staff, support and administrative staff, and students. The school administrators include the principal and vice-principals, whose primary responsibility is to provide direction and guidance for all its staff and students. The teachers play the conventional role of teaching the students. However, they also use technology innovatively to engage their students and actively participate in practitioner research to improve their pedagogical practices. The technical staff, led by the school’s ICT coordinator, play a very critical role in this activity system. They are in charge of setting up the school’s wireless network, the deployment of the Tablet PCs in the classrooms and the computer laboratories, troubleshooting of technical faults and so on. The support staff, who are led by the administrative manager and operations manager, look into the financial, procurement, and daily operations of the school. Finally, the students are engaged in learning in conventional ways and also with ICT tools.

The Objective and Outcome

The subjects of the activity system have one common objective, that is, the use of ICT for teaching and learning and in terms of the outcome, all are working towards integrating ICT into the curriculum. The expectations from the various groups that make up the community are also very clear, that is, the seamless integration and use of ICT into the curriculum and classrooms. The FutureSchools@Singapore programme is an initiative by the community within the system (i.e. the MOE and IDA) that aims to harness the use of ICT for learning. In short, the subjects of the activity system have a common and clear goal.
Contradictions and Expansive Learning

Changes and adjustments at the organisational and individual level within the school seemed inevitable with the introduction of new practices. Several contradictions emerged as the school attempted to integrate ICT into the curriculum with the ubiquitous use of computers in the classrooms. Several significant contradictions and tensions that led to an expansive form of learning are highlighted in this section.

For one thing, there were contradictions between the tools and the subjects, represented by the lightning-shaped double arrows numbered “1” in Figure 4. This contradiction was more profound especially during the initial implementation of a new tool. For instance, the teachers were not certain how they could use the ICT tools to engage their students in the teaching and learning process. It took many discussion sessions, plus their perseverance, to develop the current digital storytelling approach which they used to engage students in the creation of their multimedia stories. The digital storytelling approach was eventually used as a school-wide approach to teach English and the Mother Tongue languages (i.e., Chinese, Malay, and Tamil). Simple animations were also incorporated into these digital stories.

The contradiction between the subjects and division of labour is represented by the lightning-shaped double arrows numbered “2” in Figure 4 (page 91). Adjustments to the expectations of work in terms of the division of labour among the subjects might also be necessary with the introduction of these new practices. For instance, there were many complaints by the teachers against the technicians on the erratic performance of the wireless connection during its initial rollout. It took months for the technical staff to stabilise the wireless network. Subsequently, the teachers devised their own local practices and learnt the technical procedures necessary to get the computers connected to the wireless network. On several formal occasions during the initial months, the principal addressed and reminded all staff that with the ubiquitous use of ICT in the classrooms, extra effort would be necessary to pre-empt possible technical glitches in future. In such instances, it took leadership, perseverance, technical knowledge and time for explorations to reconcile the contradictions between the subjects and the division of labour.

The implementation of school-wide and one-to-one ubiquitous computing created contradictions and subsequent change in the rules and mindset of the subjects (i.e., the teachers). This is illustrated in Figure 4 as lightning-shaped double arrows numbered “3”. One of the concerns addressed was the usage, storage, and charging of the Tablet PCs. A Primary 1 class was chosen to pilot the use of one-to-one computing during the initial weeks as part of our efforts to look into how the Tablet PCs could be effectively used for teaching and learning. The initial and subsequent observations we made suggested that the computers could be used by students to construct digital stories and learn new things from both subscription-based and free online resources. These good practices were shared among all teachers and implemented across the school.

The initial phase in which the school tried out one-to-one computing was filled with uncertainty, as all the subjects were unsure how well the young students would react to Tablet PCs. In addition, the school also had to grapple with logistics and security issues related to housing the Tablet PCs in the classrooms. The technical team was constantly working with the industry partners to look at how the Tablet PCs could be stored and charged. After a few iterations, a customised mobile storage and charging unit was produced for use in the classrooms. The design won MOE’s INNERGY Award in 2009. The ICT department also explored using Radio Frequency Identification (RFID) for the accounting of the Tablet PCs deployed in the classrooms (see Figure 3a).

Changing the rules and practices to get teachers to be practitioner researchers was also a challenging process. Practitioner research advocates teachers to be engaged in exploration to allow them to reflect more critically and take the necessary informed actions to enhance their practices (Campbell, 2003; Elliot, 2007). Although support structures have been put in place, this change in practice inevitably added to the teachers’ workload. Examples of such support structures include forming the teachers into groups, with research activists to assist or lead, to look into an area that they would conduct research based on their interests. These research activists are teachers who are trained or are currently doing their postgraduate studies. A team approach is used, in which teachers in the groups play different roles to work towards completing the research project. It helped to ease their workload.
A practitioner research framework was also developed to provide the blueprint and structure for this effort (Tay, Lim & Lim, 2010). The principal also set the expectations amongst the teaching staff by stressing the importance of research and inquiry as a form of professional learning in their recruitment interviews and staff meetings. An annual research seminar has been planned for teachers to share their research projects with fellow colleagues, invited guests from the IHL and the industry. Again, in these instances, it took leadership, commitment from those involved, the necessary pedagogical skills to integrate ICT into the classrooms and research knowledge to reconcile the contradictions that emerged.

**Conclusion**

From the discussion of the contradictions experienced with the implementation of integrating ICT into the curriculum and classrooms, it seems to suggest that the commitment and perseverance of those involved, strong leadership together with a high level of technical and pedagogical knowledge and skills, are conditions that facilitated the implementation of these education technology innovations. These findings were congruent to those presented by Khalid, Nawawi, and Roslan (2009). From the discussion above, we can see that it was essential that the leadership was present to mediate the differences amongst the different players and set directions for the usage of ICT in the school. The rules and division of labour are to a great extent determined by the leadership of the school. In addition, the commitment, perseverance, and time put in by the various subjects allowed for further iterations and refinements to the various projects. At the individual level, both the teachers and technical staff also demonstrated their capacity and willingness to update their pedagogical and technical skills. In addition, the discussion highlighted the possible expansive form of learning that has taken place, and the findings also substantiated the call for a sociocultural perspective for the integration of ICT into the curriculum. Not only have the tools played an important role in integrating ICT into the classrooms, the rules, community, and division of labour have also collectively mediated the school’s efforts in this regard.

**Endnote**

1. Dr Tay (PhD, MA) is the Head of Department for Research and concurrent Head of Department for Information Communication Technology (ICT) in Beacon Primary School, one of the Future Schools in Singapore. He has been actively involved in the integration of ICT into the school curriculum for the past decade. He obtained his PhD from Edith Cowan University, Western Australia and Master of Arts from Nanyang Technological University. His research interest are in the areas of ICT integration into the curriculum, educational use of Multi-User Virtual Environment to re-engage academically at-risk students in academically related tasks and activities, and the use of ICT tools to facilitate the learning of higher-order thinking.

**References**


