

## A Tale of Three Cities: Review of the Development of ICT in School Education Between Hong Kong, Macau and Singapore

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### Abstract

*Background:* Hong Kong, Macau and Singapore are the top five cities/countries with the cheapest fixed line broadband as proportion of monthly income. It is interesting to know that several decades ago, they were still among the list of developing nations, struggling for survival and relief. However, they are climbing to the top in ICT development now.

*Aims:* This paper reviews the ICT development in school education of Hong Kong, Macau and Singapore with respect to their social, geographical, and economic backgrounds. Johannessen's three orders of benchmarks are proposed for the comparison.

*Method:* Literature reviews on recent reports, research articles, books and internet data were used to understand the current situation of the ICT development in education for Hong Kong, Macau and Singapore.

*Conclusion:* It is clear that these three cities' determination and relative amount that had invested in the development of ICT in education were enormous when compared with the US investment. Among these three cities, the investment of Singapore has been much larger than the other two. Singapore's apparent leading in the development of ICT in education is not an accident, especially for the first benchmarks. For the second and third benchmarks, Macau lags behind Hong Kong and Singapore, this is partially due to Macau education system is comparatively much liberal than the other two.

**Keywords:** ICT Education, Integrating IT into Teaching and Learning, Johannessen Benchmarks

### 三城記：香港、澳門及星加坡 學校資訊科技教育發展的檢討

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### 摘要

*背景：*按每月收入的相對比例計算，香港、澳門和星加坡的固網寬頻費用名列全世界最便宜前五名的城市/國家內。有趣的是，在數十年前，他們仍是在掙扎求存和需要救濟的發展中國家/地區名單中，但是他們現今已爬在資訊科技發展的前列。

*目的：*本文從社會、地理及經濟背景方面檢討香港、澳門和星加坡學校資訊科技教育的發展，以Johannessen提出的三層基準作比較。

*方法：*本文搜集近年的報告、研究文章、書籍和互聯網資料，以瞭解香港、澳門和星加坡學校資訊科技教育發展的當前形勢。

*總結：*這三個城市在資訊科技教育發展的投資決心和相對數量明顯地較美國巨大，尤以星加坡為最，故此星加坡在這方面明顯的領先殊非偶然，尤其是在第一層基準方面。在第二和三層基準方面，澳門較香港和星加坡滯後，這部分是由於澳門教育管制較其他兩地寬鬆。

**關鍵詞：**資訊科技教育、資訊科技納入教與學、Johannessen的基準

## Introduction

The small cities and towns development has been becoming the pop issue of many research areas since the 1980s especially from sociology, geography, urban planning, and economics subjects (Feng, 2001). In term of Education development, broadband and connectivity will be particularly useful in developing ICT education. Fides (2010) reported that among the top five countries with the cheapest fixed line broadband as proportion of monthly income, three are city states on the Pacific Rim—Hong Kong, Macau and Singapore. It is interesting to know that several decades ago, they were still among the list of developing nations, struggling for survival and relief. However, they are climbing to the top in ICT development now.

## Social and Geographical

During the last three decades of the 20<sup>th</sup> Century, the 4 little Asian dragons, Hong Kong, Singapore, South Korea and Taiwan maintained fast industrialization and high growth rate in their economies. They become the 4 Asian tigers of advanced and high income economies in the 21<sup>st</sup> Century.

Actually, Hong Kong and Singapore are two cities while the other two are much larger countries. Both cities were former British colonies, with a population of comparable size and race, using English and Chinese as the major language in the society, etc. In the last few decades, these two cities compete keenly with each other in many different areas. Many comparative studies in education have been done between these two cities in the past (e.g. Manzon, 2004; Mok & Tan, 2004; Quek, Ho, & Soh, 2008; Tsou, 2002; etc.).

Geographically, Hong Kong and Macau are two cities located at the opposite sides of the mouth of Pearl River, less than 40 miles away from each other. Historically, they were a part of China, became European colonies, and then returned to China near the end of the 20<sup>th</sup> Century as a Special Administrative Region (SAR). The two SARs of China enjoy a high degree of autonomy in all aspects (except for defence and foreign affairs) that allow them to develop freely as an independent economy. There are also many comparative studies in education related with these two cities (e.g. Bray & Koo, 2005; Hui, 1999; Yu, Kwong & Yu, 2009; 2003; 1998; etc.)

Table 1

*Some Basic Information of These Three Cities*

	Hong Kong	Macau	Singapore
Colony	UK[1842-1997]	Portugal[1557-1999]	UK[1819-1955]
Sovereignty	SAR of China	SAR of China	Independent
Area [sq km]	1104	29.5	710
Population[2000/2010 in millions]	6.7/7.06	0.43/0.55	4.03/5.08
% of Chinese	95[2006]	95[2006]	74.1[2010]
% of non-residents	about 5%	7.5/13.8[1999/2009]	18.7/25.7[2000/10]
Median age	42.8	35.6	39.6
Total fertility rate[CIA]	1.07	0.92	1.11
Life expectancy	82.04[8]	84.41[2]	82.14[7]

The population of these three cities is mainly Chinese, rather homogeneous in Hong Kong and Macau, but with a significant portion of other races in Singapore (Chong & Cheah, 2010). These three cities are small in area but with a high population density. They have the lowest fertility rate in the world. The median age indicates that their populations are not young.

All these three cities are among the top ten life expectancy states in the world, indicating a high

measure of overall quality of life [CIA webpage, 2011].

### Economic

Getting into the 21<sup>st</sup> Century, Macau quietly ascends to become one of the top economies of Asia. She took over Las Vegas and becomes the number one city of casino industry in 2007. Evidently, Macau has developed to a state that is comparable with Hong Kong and Singapore in many different aspects.

Table 2

*Some Social and Economic Measures of These Three Cities*

	Hong Kong	Macau	Singapore
Per Capita of GDP at ppp[US\$]	35,680	37,256	41,479
Human Development Index [07 data]	0.944	0.944	0.944
Gini coef of income equality [09 data]	0.434	0.48	0.425
% of unemployment	3.5	3.0	1.9
Corruption Perceptions Index	8.4(13)	5.0(46)	9.3(1)

Per Capita measures of GDP at ppp [purchasing power parity] are useful for comparing the average standard of living in different economies. These three cities are among the top ten economies of the world, with Singapore 7<sup>th</sup>, Macau 9<sup>th</sup> and Hong Kong 10<sup>th</sup> (Wong, 2008).

The UN Human Development Index (HDI) is a statistical measure of factors that gauges a country's level of human development. There is a high correlation between having a high HDI score and a prosperous economy. However, HDI accounts for more than income or productivity; it takes into consideration how income is invested into education and health opportunities, i.e. higher levels of human development. Incidentally, all three cities ranked 24, with an index of 0.944 in the 2007 HDI world statistics. All these three cities are among the level of

very high HDI countries (Wikipedia, 2010).

Gini Coefficient is a measure of the income inequality among the entire population of a country. According to Einhorn (2009), Hong Kong and Singapore have the largest Gini coefficient among the top economies. Actually, the coefficient of Macau is even larger. It indicates that the differences of poor and rich family are rather serious among these three cities.

The unemployment rates are low in these three cities. Even though Hong Kong has the highest unemployment rate of 3.5% among the three, it is still about the same as Switzerland or Norway, which are the lowest among the top developed economies (Wikipedia, 2011).

## Education

How is the education development of these three cities comparing with the other countries? From Table 3, these three cities' public expenditure on education, no matter measure as percentage of GDP or government expense is not high. However, their students' achievement in mathematics, reading

and science are very good among the international studies, e.g. PISA 2009 (OECD, 2010). This seems to be a common phenomenon among East Asia countries. Parents consider education is a very important investment on their children. There may be a lot of implicit expenditure from the parents that cannot be shown from the government figures (Bray, 2009).

Table 3

*Some Basic Educational Input and Output Measure of These Three Cities*

	Hong Kong [2009]	Macau [2009]	Singapore [2009]
Public expenditure on edu			
as % GDP[CIA, 2011]	4.5(80)	2.2(152)[08 data]	3.0(131)
as % govern expense	20.2	14.0	15.3[08 data]
PISA (2009)			
Reading	533(4)	487(28)	526(5)
Science	549(3)	511(18)	542(4)
Mathematics	555(3)	525(12)	562(2)
Free Education age range	6-18	3-18	6-16
Common system of assessment	yes	no	yes

Macau has the longest period of free education (15 years) for her students. The extra years more than those other two cities are mainly due to the provision of free kindergarten to children. However, the kindergarten attendance rate are about the same among these three cities (OECD, 2010a, p.239), indicating parents will still send their children to school no matter there is government assistance or not. There is no government or aided kindergarten in Hong Kong and Singapore. On the other hand, Macau just has a small percentage of private kindergartens (14.5%) indicating more emphasis at this level. In the recent decade, Hong Kong begins to have more government subsidy to early childhood education through direct subsidy to parents (Hong Kong SAR, 2006) while Singapore still keeps an arm's length

away at this stage.

Furthermore, Macau's percentage of expenditure on education (14%) is the lowest among these three cities. This is contrary to public understanding of more money leads to longer provision of education. It may probably be due to the much lower recurrent expense per pupil (US\$3677) there as shown in Table 4.

The student-teacher ratio and class size in the secondary schools of these three cities are about the same. There are some differences in the primary schools, with a lower value in Hong Kong and a higher value in Singapore. Actually, all these 3 cities are put under the category of low cumulative expenditure in education with large class size and high teacher salary (OECD, 2010a).

From the high percentage of government schools in the primary (76.2%) and secondary level (77.9%) of education in Singapore as shown in Table 4, we know that the Ministry of Education (MOE) in Singapore has a firm control while Hong Kong and Macau's control are rather loose. Even though these two cities have about the same percentage of private schools and government schools in these two levels, the government control actually differs a lot. The aided schools in Hong Kong are tightly controlled by a set of code of aid plus government quality inspections.

Macau Education and Youth Affairs Bureau (DSEJ) has direct control on the few government schools but only impose loose control on the rest of

schools. The private independent schools in Macau receive much less subsidy compared with Hong Kong aided schools, but enjoy more freedom in exchange. In general, these other schools are lack of uniformity in the curriculum and teacher salaries. It is difficult to implement teacher competence indicators for schools to abide.

Another special feature of Macau education is the relatively high percentage of repeaters comparing with those other two cities. Wu (2007) explained that was due to a high percentage of private independent schools in Macau that had a lot of freedom in their own school policies. These schools are not convinced about the concept of wastage linked up with school repeaters.

Table 4  
*Some Educational Measure of These Three Cities*

	Hong Kong [2009]	Macau [2009]	Singapore [2009]
<b>Kindergarten</b>			
% attendance	97.2	96.8	97.7
% private	100	14.5	100
student-teacher ratio	9.6	17.6	
% trained teacher	95.7	95.3	
<b>Primary school</b>			
% of recurrent ed expense	21.5		26.6
recurrent expense per pupil[US]	4208	3677*	4232
% private	18.7	13.1	0
% government	6.3	0	76.2
% repeaters	0.8	5.2	
student-teacher ratio	15.7	17.3	19.6
class size	29.8	31.0	34.4
% trained teacher	95.4	86.1	(100?)
<b>Secondary school</b>			
% of recurrent ed expense	38.2		33.8
recurrent expense per pupil[US]	5273	3677*	5898
% private	23.9	19.4	3.9
% government	6.2	6.3	77.9
% repeaters	3.9	10.5	
student-teacher ratio	16.0	17.1	16.4
class size [S1-5]	36.1	35	36.5
% trained teacher	94.0	70.8	(100?)

*Note.* \* The Government did not break down the expense into levels of education. Thus an average for each student was counted. There are also other expense from other departments for schools and students, so the recurrent expense per pupil should be over US\$3677, particularly in the secondary school level.

### **Development of ICT in Education**

ICT is an essential tool for people living in today's society. The goal of ICT in education is to develop ICT skills for problem solving in real life. There are three major uses of ICT in school education. Its first use is to improve teaching and learning — including the use of application software as a teaching and learning tool. The second use is to enhance administrative efficiency — such as grading and keeping records in schools for tracing a student's learning history and performance. Third, ICT is used to build information literacy of students (Smaldino, Lowther and Russell, 2008; Heo and Kang, 2009). On the other hand, Trucano (2005) reported there was not enough conclusive data to support the above benefits of ICT in education.

Singapore formally began their development of ICT in education in 1997, Hong Kong in 1998, and Macau in 2001. Up till now, there has no agreed international framework for benchmarking ICT in education. Johannessen (2009, p.18-19) proposed a way to distinguish between different types of benchmarks for ICT in education--dividing them into first, second and third order benchmarks. A majority of the information reported below were collected from the following reports (Ang et al, 2008; Education Bureau, 2007 & 2009; Education and Manpower Bureau, 1998 & 2004; Lee et al, 2008; Macao Education and Youth Affairs Bureau, 2011; Ministry of Education, 2008; Pricewaterhouse Coopers, 2000).

#### **First Order Benchmarks**

The First order benchmarks are typically related to access to ICT. This could be pupil: PC ratio and broadband access.

#### **Internet and computer penetration.**

In 1998, the student-computer ratios in primary and secondary schools in Hong Kong were 53.3 and 35.7 respectively, which were rather low levels of hardware provisions among the participating countries at the time (Pelgrum and Anderson, 1999). Law, Lee, and Yuen (2009, p.161) found that some basic measures of infrastructure had been achieved in all publicly funded schools during 1998-2006. In 2007, all public sector schools in Hong Kong had broadband connection to the Internet. The student-to-computer ratios decreased to 6:1 in primary schools and 4:1 in secondary schools. 95% of primary and secondary school students had access to computers at home. Out of these students, 97% had access to the Internet at home (Education Bureau, 2007).

In 2006, the student-to-computer ratios were 8:1 in primary schools and 6:1 in secondary schools of Macau. In 2007, every teacher had at least one computer to use in school. In 2008, more than 95% of schools had installed intranet and broadband internet (Fan, 2010).

By the end of 1999, the teacher-computer ratio was 2:1 for all schools and student-to-computer ratio was 6.6:1 for primary schools (Lim, 2007), and 5:1 in secondary schools in Singapore. In 2002, a basic infrastructure for ICT was completed in all Singapore schools. MOE planned to support ultra-high speed broadband connectivity for schools by 2012 so that they can engage in anywhere, anytime learning. They also study how to put a low-cost laptop or a digital PDA computing power in the hands of every student to enable mobile learning (MOE, 2008).

#### **Funding.**

During 1998-2007, the non-recurrent expenditure in Hong Kong for the development of ICT in education on initial set up of infrastructure

and purchase of equipment & services for schools, school IT related projects, and other miscellaneous items was about US\$690 million. The recurrent expenditure in hiring of technical personnel or services, maintenance and repair, refresher training of teachers, and other daily consumables was about US\$232 million (Education Bureau, 2007).

In 2008, Macau DSEJ reported US\$33.8 million was invested in similar ICT development (Fan, 2010).

Singapore invested about US\$1 billion for

similar ICT development during 1997-2002.

In order to make meaningful comparison about the ICT in education investment between these three cities, we need to have some baselines. Kozma (2005, p.118) reported that the US Government budgeted over US\$690 million on educational technology to its states in 2004. Table 5 is a comparison of ICT in education expenditure between these three cities with US as a baseline.

Table 5

*A Comparison of ICT Education Investment of These Three Cities*

	Hong Kong	Singapore	Macau	US
ICT exp (US\$million)	922 (98-07)	1000(97-02)	33.8(01-07)	690(04)
Annual exp per head(US\$)	14.6	39.4	10.2	2.2

Strictly speaking, these figures cannot be compared as the years are different and the buying power may not be the same in the four places. However, these are the best we can find from literature. The US figure might appear too low when compared with the other three cities. However, this was just the expenditure from the Federal Government, the State Government budget did not appear here. It is mainly used as a reference point.

## Second Order Benchmarks

This order of benchmarks tries to capture in what ways and to what extent ICT is used in teaching and learning. These benchmarks can cover a wide range of use patterns and learning technologies, and they should capture both teachers' and students' use of ICT for learning.

### Curriculum.

#### *Way of implementation.*

Hong Kong adopts a dual path model, the

Education Bureau (EdB, the same as Education and Manpower Bureau, EMB, before 2005) takes the curriculum leading role while school-based curriculum are actively encouraged. The aim is to let students become habitual IT users to learn in schools and use in jobs in their future workplace,... to develop in our students the attitude and capability for independent lifelong learning (EdB, 2009a).

Macau DSEJ required schools to develop school based teaching/learning or e-learning platform in order to get government funding (Fan, 2010)

Singapore mainly uses a top down model, the Ministry of Education (MOE) decides and schools follow. After the first two stages of Master plan for ICT in education, one important lesson they learned was the value of autonomy instead of top down control. There are more school based projects similar to Hong Kong in recent years (MOE, 2008).

#### *Integration of IT with teaching.*

Use of computers for instructional purposes in

non-computing subjects was rare before 1998. The target for the development of ICT in education of EMB in the first stage was to ask individual schools in Hong Kong to decide freely for at least 25% of their own teaching to integrate with IT. During 1998 to 2006, there had been some gradual change in teaching, pedagogical innovation integrated with ICT use moved from rare to more integrated with subject areas. In 2006, a teacher survey showed 70 % of mathematics teachers and 82 % of science teachers reported having used ICT with the sampled grade 8 classes that they taught in that school year. This was among the highest percentage reported in the participating countries. This finding indicated that in terms of classroom adoption, the Hong Kong government strategies had achieved noticeable success (Law, Pelgrum and Plomp, 2008). In 2007, there were more than 50% of teachers frequently using IT in their teaching. The current aim is to enable teachers to use the right technology at the right time for the right task. The EdB adopts a two-pronged approach of providing teachers with practical advice on how to integrate IT into learning and teaching and building their IT capacity (EdB, 2007).

In 2004, over 80% of Macau grade 6 teachers integrated IT into their classes for around once a week. More than 90% of teachers had IT integrated at least once a week in their grade 9 classes (Fan and Zhang, 2004b). However these figures did not clearly describe how IT was integrated.

Singapore set the initial target of teaching-IT integration at 30% in 1997. They are now moving to the stage that requiring 'students to use ICT to look for information, synthesize reports, give feedback on each others' work and collaborate with peers within and outside school' (MOE, 2008).

### **Education resource.**

In the initial phase of development ICT in education from 1998 to 2003, the Hong Kong EdB focused on providing schools with IT equipment, connecting them to the Internet, and the development of digital learning resources (EdB, 2007, p.9). At present, the EdB is moving in the direction to provide practical advice and appropriate digital resources, such as teaching modules that should enhance teachers' confidence and reduce their burden in integrating IT into the learning and teaching process. The HKEdCity website [<http://www.hkedcity.net/>] is the platform to serve as the proposed depository of teaching modules. It is currently hosting a collection of digital resources for different subjects at different academic levels, disseminating good IT pedagogical practices to teachers (EdB, 2007).

There is no regular ICT development phase in Macao, however, from 2007 onward Macau DSEJ launched a program to finance school to improve the ICT development. The funded program must satisfy at least one of the set criteria laid down by DSEJ which includes improving overall IT infrastructure, promoting teachers IT knowledge to support teaching, fostering appropriate IT skills to support school reform and development. The set criteria are:

1. to improve networking and wireless network infrastructure; to install classroom projectors and screens; to purchase notebook computers for teachers; to improve campus network and classroom settings;
2. to develop school based teaching/learning or e-learning platform to enhance learning and teaching;
3. to develop a school management system to improve information exchange and school administration;

4. to improve the IT competence of teaching staff, administrative staff and students;
5. to enrich the educational resources. This also includes organizing teachers to purchase teaching materials and educational software to enrich their school resources;
6. to enhance IT literacy; to cultivate the concepts of decent use of IT; to master the skills for lifelong learning and higher order thinking; to use IT as a tool for information exploration; knowledge acquisition; communication; collaboration and professional development. To equip learners with the ability to discover, analysis, evaluate and solve problem (Macao Education and Youth Affairs Bureau, 2011).

Singapore MOE developed the first digital repository project for teachers to share their lesson plans with other teachers in 2006. She supports the establishment of a network of educational labs, where innovations can be prototyped and tested. Good practices and successful innovations can then be quickly disseminated to the wider community (MOE, 2008).

#### **Human resource management.**

##### ***Professional development.***

In 2003, all the teachers in Hong Kong (about 50,600) completed the basic IT training, 77% passed the intermediate level, 27% got to the upper intermediate level, and 6% reached the advanced level (EMB, 2004, p.1). The IT professional development framework for teachers was revamped with the new framework emphasized professional development needs in four dimensions, viz. technical knowledge, pedagogical integration, managing and leading IT, and socio-cultural awareness in using IT (Fitzgerald, 2004). In 2005, the focus of training shifted to e-leadership for school heads. In 2007, all

teachers were required to have grasped the basic skills of using IT to teach while some venture with more sophisticated tasks such as real-time activities with English-speaking students in other areas of the world via the Internet. The EdB continues to offer refresher courses, seminars and workshop to keep teachers updated with skills on using the latest technologies to enhance learning and teaching activities (EdB, 2007).

In terms of IT education, Macau DSEJ offers teachers short courses on IT education, Courseware Development, Web Page Design and various computer packages (such as PowerPoint, Flash, Premiere). There are also courses related with education concepts for IT administrators who are not teachers initially. DSEJ will fund schools to organize their school based training programs according to their individual needs (Fan, 2010).

During the initial period 1997-2002, Singapore MOE adopted a different approach to train teachers. Sixty senior ICT instructors from schools, educators who shared the goals of the benefits of ICT and were role models themselves were grouped into teams. These teams of instructors were sent to each school to do training. In this way, the entire school moved as a whole, infused with a culture of using ICT, learning from each other, and learning to use ICT in the context of teaching. Each teacher received at least 30 hours of training. Since then, teachers in general have the passion, commitment and willingness to learn new skills and employ ICT to improve learning outcomes (MOE, 2008).

##### ***Manpower.***

Hong Kong EMB employed contractors or provided a grant for schools to hire service for technical support. The teacher who is responsible for IT is eligible for promotion (EMB, 2004).

In 2008, the DSEJ sponsored Macau schools

to employ IT administrators to assist schools in developing IT in education (Fan, 2010).

In 2008, each Singapore school has identified a cadre of teachers with strong pedagogical background as expert teachers to lead effective integration and infusion of ICT into the classroom and the curriculum (MOE, 2008,).

### **Third Order Benchmarks**

This order of benchmarks covers the impact of ICT in teaching and learning. Benchmarks should be related to learning outcomes and learning strategies.

#### **Assessment.**

Hong Kong teachers evaluate students attainment according to the learning targets outlines in the Information Literacy (IL) framework. Assessments are performance based with formative evaluation information and IT enriched pedagogy (EMB, 2004). Research indicated most students had some basic technical skills in operating the computer, using the basic functions in the office suite of applications and surfing the web. Students competence in lower-level IL skills such as defining and accessing information were good but were poor in solving more complex tasks involving information literacy skills. Students' performance in the dimensions 'integrate', 'create', 'communicate' and 'evaluate' were poor, especially for items requiring the use of digital tools specific to the subject discipline. Learning experience in school affected students' information literacy achievement. There was still a long way ahead between students' ICT use in classrooms and nurturing 21st century skills (Law, Lee, and Yuen, 2009, p.160). Hong Kong has participated the IEA International Computer and Information Literacy (CIL) Study in 2010. This study will examine the outcomes of CIL across countries. CIL refers to an individual's ability to use computers

to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in the community. The main data collection will occur at the beginning and end of 2013 for northern and southern hemisphere countries (IEA, 2011)

Macao evaluates the IL of students in three areas. This included the competence on (1) operating office suite of application, (2) surfing web resources (email and browsing information) and (3) programming (Fan and Zhang, 2004a). Research indicated that there was not much difference in compare with other advanced and neighboring countries (Fan and Zhang, 2004a, p. 63).

Singapore MOE is planning to use ICT in assessment in selected subjects and levels. Through the use of individual PDAs, a teacher could ask any question any time during her lesson and get real time feedback of what each student has understood (MOE, 2008, paragraph 42).

### **Discussion**

It is easier to check whether these three cities have achieved the first order benchmarks on development of ICT in education through those objective criterions. The OECD student-to-computer average ratio was 5 to 1 in 2003. It remained about the same since then (Francesc, 2009). These three cities have about the same student-to-computer ratio, Singapore reached this in 2002, Hong Kong and Macau got to that a little later. Actually, this benchmark is a little bit out of date for the advanced ICT countries as it remained about the same after 2003. What is important now is the speed of the computer.

In OECD countries, 88% of computers in school were connected to internet, 76% of students could

access internet at home (Francesc, 2009). For Hong Kong and Macau schools, 95% had connected to internet while 97% of Hong Kong students could access internet before 2007. Singapore schools and students are even more advance in this benchmark.

Table 5 shows the expenditure of ICT annually per person for these three cities. The value of US listed here is just as a reference since US is a symbol of advance country in science and technology. It is clear that these three cities' determination and relative amount that had invested in the development of ICT in education were enormous when compared with the US investment.

Among these three cities, the investment of Singapore has been much larger than the other two. Her generous investment of ICT in education was not a separate incident but actually followed the track of her national policy dated back to the early 1980s (Koh & Lee, 2008). In those days, Hong Kong and Macau were still a colony facing the unknown future of change of sovereignty. So Singapore's apparent leading in the development of ICT in education is not an accident, especially for the first benchmarks.

For the second and third benchmarks, Macau lags behind Hong Kong and Singapore, where Macau school system is much liberal than others. Since the majority of schools in Macao are private, the Ministry of Education is difficult to impose certain measures on the schools' internal policies on ICT education. Unlike Hong Kong and Singapore, Macao never officially publishes any long term planning or goal for the next 5 to 10 years especially the target on percentage of ICT integration within certain years.

On the other hand, the policy of ICT in education announced in 1998 by the new Hong Kong SAR Government just one year after the decolonization

could be considered as the vision and flexibility of her leader and education minister in response to the outside world. Similarly, Macau was decolonized two years after Hong Kong. Her move to join in the development of ICT in education in 2001 was not slow, even though she might be considered as a follower of Singapore and Hong Kong. However, Macau is much smaller in size than the other two cities. This allows her to be more flexible and easier to govern. In the recent few years, the extension of free education to 15 years and the fast development of ICT infrastructure of schools are clear indications of her advantages.

On the whole, Hong Kong, Macau and Singapore have substantial amount of investment in ICT education. Based on the comparison result from Johannessen's three orders of benchmarks, Hong Kong and Singapore have development a vision on ICT education and certain goals have been achieved in the past years. Macau has the most liberal education systems among them. Although there is no specific planning or target for schools to follow, the strong GDP and flexible schools policies lead the ICT education in Macau a substantial improvement in the past ten or more years. No matter which kind of perspectives they are taking, students will be the beneficiary from the advancement of ICT education.

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