【Education Policy Studies Series】

Student Performance in Chinese Medium-of-Instruction (CMI) and English Medium-of-Instruction (EMI) Schools: What We Learned from the PISA Study

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Education Policy Studies Series

Education embraces aspirations of individuals and society. It is a means of strengthening human resources, sustaining competitiveness of society, enhancing mobility of the underprivileged, and assimilating newcomers to the mainstream of society. It is also a means of creating a free, prosperous, and harmonious environment for the populace.

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Student Performance in Chinese Medium-of-Instruction (CMI) and English Medium-of-Instruction (EMI) Schools: What We Learned from the PISA Study

Abstract

The Education Commission took action to decide on a mandatory medium of instruction (MOI) policy in Hong Kong secondary schools in 1998. Secondary schools were categorized into either English medium-of-instruction (EMI) or Chinese medium-of-instruction (CMI) schools. Using the data from the first cycle of the Programme for International Student Assessment (PISA) by OECD (Organisation for Economic Co-operation and Development), this article focuses on this important language policy issue.

The article begins with a brief review of the context of the language policy in Hong Kong. Then, the major empirical studies concerning language policies and practices in Hong Kong are analyzed. Finally, we present the research findings and examine the relationship between student outcomes and MOI tracking based on an analysis of the Hong Kong PISA data. Implications for educators, researchers and policy makers, and recommendations for further research and practice are discussed in the final section.

Introduction

The Programme for International Student Assessment (PISA) by OECD (Organisation for Economic Co-operation and Development) represents a new collaborative effort of over 40 countries in monitoring the outcomes of education systems in terms of student literacy, within a common international framework. This is the first time when reading, mathematics, and science assessment takes place together as an integrated study. The main purpose of PISA is to establish the relative levels of quality and equity of achievement and to identify factors affecting levels of literacy in the three domains of reading, mathematics, and science.

This article focuses on a major language policy issue. The purposes of this article are threefold. First, we explore to what extent the test language affects student performance in reading, mathematics, and science. Then we examine if students' literacy performance is related to different types of schools defined by the present medium of instruction (MOI) and tracking policies. Finally, we will investigate to what extent these differences in performance, if any, can be explained by the student intake of different types of schools.

We believe that it is important to evaluate whether students are able to use English competently for learning after having been instructed in English under the MOI policy. Such findings might inform us of the impact of the present MOI policy on students' cognitive and affective learning outcomes.

The article is organized into six sections. The first section introduces the background of PISA and the purpose of this article. The second section reviews the context of the language policy in Hong Kong. The third section is an analytical review of the empirical studies in Hong Kong. The fourth section describes the design and methodology used to address the major research problems identified in previous sections. The fifth section presents the research findings and examines the relationship between student outcomes and MOI tracking based on an analysis of the Hong Kong PISA (HK-PISA) data. The last section summarizes the major findings, examines implications for educators, researchers and policy makers, and offers recommendations for further research and practice.

The Context of Language Policy in Hong Kong

Universal Education and the MOI (1978–1994)

Hong Kong has a unique language policy based on its history. Hong Kong was a British colony for more than a hundred years. Building on the elite education system of the United Kingdom, students were highly stratified according to student's social background before the introduction of universal compulsory education in 1978. Children from the "upper class" were more likely to benefit from this kind of "pyramid" system. Only a small proportion of elites (the tip of the pyramid) went to the top schools to receive higher education, whereas a large proportion of students (the base of the pyramid) joined the labor market at different stages of their education. Children from the "lower class" needed to work much harder if they wanted to catch up with their counterparts. This kind of system played a special role in the differentiation of the labor force at the expense of social mobility.

The introduction of universal education in Hong Kong in 1978 provided a chance to improve the opportunity of working-class children to education. All Hong Kong children, regardless of their social background, were eligible to receive 9 years of free education until the age of 15 in 1978. This challenged the education system in Hong Kong in some important aspects. As Tsang et al. (2004) argued: it is unreasonable to require students from various backgrounds to catch up with a curriculum which was largely elitist. Therefore, the old curriculum was reviewed and a new curriculum introduced. As more students from the working class entered secondary school, their English standard was no longer guaranteed as in the elitist period. This problem was more severe in less prestigious schools where students had less exposure to English and often suffered from being taught in English.

In 1982, a Visiting Panel headed by Sir John Llewellyn was invited to review the education system in Hong Kong. They advocated the use of the mother tongue in a document named *A Perspective on Education in Hong Kong* to solve the problem of the MOI. The panel contended that:

> An obvious way out … is for the Government to impose Cantonese as the medium of instruction in FI–III of all secondary schools so that the first nine years of schooling (PI–FIII) would be in the "language of the heart". A pragmatic variant on this would be to leave alone the small number of schools which have been genuinely successful in using English as a medium of instruction. (Llewellyn, 1982, para. III.1.17)

It should be noted that the Visiting Panel did not recommend the exclusive use of Cantonese as the MOI. They pointed out that there were political and economic reasons to maintain students' proficiency in English. In other words, there was a dilemma of making a balance between adopting Cantonese as an MOI and maintaining economic and political connection with the rest of the world. The report continued:

> whether to jeopardize the educational progress of the majority (and perhaps endanger the culture itself) in order to guarantee a sufficient number of competent English speakers; or to value the whole group (and in so doing conserve the culture) but accept the loss in capacity to deal with the international environment and hence a possible decline in the economic prosperity. (Llewellyn, 1982, para. III.1.19)

Thus, the panel suggested a compromise solution that there could be Chinese medium-of-instruction (CMI) education after Primary 6. They suggested that there should be a progressive shift to bilingualism from Form 1 to Form 3.

Two years later, the Education Commission (1984) addressed the MOI issue by adopting a let-school-decide policy:

> We RECOMMEND that individual secondary school authorities should be encouraged to adopt Chinese as the medium of teaching. We consider that this should be achieved not by mandatory action but by a policy of "positive discrimination" in favour of schools which adopt Chinese as the medium of teaching. (para. 3.18; emphasis original)

The Education Commission (1984) continued to elaborate on "positive discrimination":

> We further RECOMMEND that secondary schools … should be given additional resources to strengthen the teaching of English to avert any consequential drop in the standard of English due to reduced exposure. (para. 3.19; emphasis original)

From Voluntary to Mandatory (1994–1997)

It was clear that "positive discrimination" could not convince most schools to change into using Chinese as their MOI because most parents did not accept it. Furthermore, schools using Chinese as the MOI were threatened that there would be an erosion of high-quality students to schools using English as the medium. Anglo-Chinese schools in Hong Kong took a conservative stance toward the proposed change and tried to avoid the uncertainty associated with the change.

This forced the Education Commission to take a 180-degree turn in their stance toward "mandatory action." In the *Education Commission Report No. 4* (Education Commission, 1990), it laid the foundation for "firm guidance," something which was originally related to target-related assessment:

> From 1994 onwards, schools will have been provided with results from the HKATS or target-related assessments. However, despite the information derived from these assessments and ED's [Education Department] advice, some schools may still be reluctant to change their teaching medium and defend their position by pointing to, for example, poor student intake.

> … With the second administration of Secondary 3 target-related assessments in 1998–99 … Strong evidence can then be presented to schools to demonstrate that they have made the wrong choice and D of E [the Director of Education] will be in a good position to give firm guidance to schools towards the right teaching medium. Full implementation of the language policy will thus be achieved in 1998–99. (para. 6.5.11)

It was unfortunate that the Education Commission made the above guidance with perhaps a little too much confidence since target-related assessments were still at a premature stage. Yet the assessments were thought to be useful for providing "strong evidence" on the choice of the medium of teaching in school. Nonetheless, the policy marked the use of assessments and administrative means to force schools to comply with the suggested language use for teaching. Eventually, this idea was rectified in the consultation document *Medium of Instruction Guidance for Secondary Schools* (Education Department, 1997). The *Guidance* suggested that all secondary schools in Hong Kong were mandated to adopt Chinese as the MOI unless they could be proven otherwise. The only exceptions were those who can provide evidence for:

- student ability to be an average percentage of not less than 85% of Medium of Instruction Grouping Assessment (MIGA) Groups I and III students in Secondary 1 intake for the past three years;
- teacher capability to be based on the principal's assessment and certification; and
- support strategies and programmes (such as bridging courses) to give sound school-based assistance to students. (para. 2.4)

The MIGA was a norm-reference construct to classify students into different MOI groups. The MIGA results were released to primary schools and parents in 1994. In 1997, 100 schools out of 400+ were granted the EMI (English as Medium of Instruction) status and another 14 schools were also granted the EMI status after they appealed. With the EMI status, schools were specified to use English as the MOI in all subjects except Chinese language and Chinese literature.

MOI Policy and School Segregation

The MIGA of MOI and the bandings in SSPA (Secondary School Placement Allocation) are two different tracking systems. Both have strong implications on the academic segregation of the secondary school system in Hong Kong. Since the introduction of universal education in Hong Kong, the SSPA mechanism replaced the Secondary School Entrance Examination (SSEE). In 1978, under the SSPA mechanism, graduates of primary schools were classified into five bands. Band 1 students had the highest priority in being allocated into their first choice of school whereas lower-banding students had lower priorities. On the one hand, this allocation system reduced the pressure of the previous SSEE public examination at the end of primary education. On the other hand, this mechanism eliminated the adverse effect of random allocation — i.e., reducing the large range of ability within the same school that the school finds difficulty in dealing with. This could be seen as a balance between relaxing the examination pressure and keeping the homogeneity of students within school.

The bandings were expected to have strong association with MIGA as they were both indicators of students' academic achievement. Students from Band 1 schools were likely to be competent in both English and Chinese. They were likely to be in categories I or III in MIGA. In addition, due to the prestigious status of English in Hong Kong, higher-banding students tended to choose EMI schools. Consequently, an unintended outcome of the SSPA mechanism was the allocation of high-banding students to EMI schools.

Tsang et al. (2004) argued that the MOI policy might have increased the degree of academic segregation among schools in Hong Kong. This argument could be examined by comparing the segregation index of schools before and after 1997. Evidence given by Tsang et al. on the segregation index in 1994 was that: the percentage of variance of Academic Achievement Index (AAI) between schools was about 75% and that of within school was about 25% (p. 35). In Tsang et al.'s MOI study, over 80% of variance of AAI in 1998 and 1999 were between-school variance and less than 20% of them were within-school variance. Tsang et al., therefore, argued that the segregation between schools increased because of the MOI policy.

It would be interesting to use the PISA sampled schools to estimate the trend of academic segregation index. This would provide essential clues to the change of segregation over time. Table 1 displays the five years of academic segregation index between schools from 1996 to 2000. The results indicate that the segregation indices have been about 80% since 1996, which appears to be very stable across the following four years. Therefore, results do not support the argument that the MOI policy increased the segregation in 1998.

Table 1. Variation of AAI Between Schools From 1996–2000 (PISA Schools)

Variance	1996	1997	1998	1999	2000
Variance between schools	190.85	189.44	191.96	187.49	189.98
Variance within schools	40.41	38.63	35.65	40.10	39.83
Total variance	231.26	228.07	227.61	227.59	229.81
Percentage of variance					
Between schools	0.8261	0.8326	0.8451	0.8238	0.8326
Within schools	0.1739	0.1674	0.1549	0.1762	0.1674

Summary

In this section, we have reviewed the changes in language policy in the universal education context in Hong Kong. In particular, the nine-year compulsory education introduced in Hong Kong in 1978 had an impact. The education system was no longer designed to serve the elites but to provide basic education to all students regardless of their social background. This change posed new challenges to the original elitist education system inherited from the British system. Of all the challenges, the MOI is one of the most controversial and widely discussed.

The introduction of universal education which allowed children of different backgrounds to receive education appears to be in contradiction to the use of a second language (L2) as an MOI in Hong Kong. The business sector and the government argue that it is desirable to keep instruction in English so that Hong Kong can maintain its competitiveness and connection with the rest of the world. However, some educators found that only a small proportion of top students could benefit from using English as an MOI, given Hong Kong's sociolinguistic environment and insufficient high-quality teachers for all, whereas the rest of the students were more appropriately to be instructed in Chinese. These led to the question of who should receive instruction in English and who should not, and what are the criteria for distinguishing the two.

The government adopted a voluntary approach to the MOI policy in 1984 and tried to provide extra incentives to those schools which would use Chinese as the MOI. However, schools were reluctant to change to using Chinese for different reasons such as the low prestige of Chinese, less social mobility, and so on. Parental choice was clearly in favor of English. The positive discrimination approach proved to be a complete failure. The Education Commission then took a more aggressive and administrative approach in 1990 and suggested using some assessment (e.g., Targets and Target-Related Assessment [TTRA]) results as the basis for deciding which schools should be taught in English or Chinese. Although no TTRA result was finally available, a mandatory regulation for schools to choose the right MOI was released in 1997 and it was enforced in 1998. This MOI policy was supposed to help schools and parents to choose the most appropriate MOI for students to learn more effectively. Yet researchers argued against it because of the unintended outcome of increasing the segregation between schools.

However, results from PISA's Hierarchical Linear Models (HLM) analysis which partition the total variance of student academic achievement indicated that the academic segregation between schools did not increase under the MOI policy. In fact, the academic segregation index did not change from 1996 to 2000. It appears that the implementation of the MOI policy in 1998 had had no effect on the degree of academic segregation of the school system. Yet, the stable academic segregation index of 80% reflected that Hong Kong does have a highly academic segregated secondary school system. The Education and Manpower Bureau proposed the desegregation reform in 2001 by reducing the bandings from 5 to 3, which appeared to be a remedy to reduce the degree of academic segregation among schools. Since this desegregation policy was implemented in 2001–2002, further analysis by 2006–2007 is needed to examine if the policy can successfully provide a more equal and less differential schooling system.

Literature Review

In the previous section, we have discussed the language policy, especially MOI, from its historical and social context in Hong Kong. We will focus on the empirical evidence assessing the effect of MOI on learning outcomes based on current local and international research studies.

Llewellyn (1982) argued that it was contradictory to introduce universal education yet allowed students without adequate English ability to enter into English-dominated secondary classrooms. It questioned whether students, regardless of their English language ability, could benefit effectively from English as an MOI. In addition, there was also a concern that code-mixing and code-switching used in most Anglo-Chinese secondary classrooms were detrimental to students' learning. Johnson's (1983) study reported that teachers code-switched every 18 seconds to the detriment of students. A teacher-reported survey conducted by Shek, Johnson, and Law (1991) revealed that the use of English textbooks was always accompanied by explanations in Cantonese. Both English and Chinese were used in various proportions depending on students' banding and school context. This led to another question of whether such an approach of using mixed code for instruction could effectively help students with lower English ability to learn (see Lin, 1997 for discussion of the issue).

Effect of MOI on Learning Outcomes

While examining the effect of MOI on learning outcomes, there are several variables that should be taken into account. First, the impact of the MOI may vary across students with different language abilities. It is likely that students with high English ability tend to benefit most when they use English as the MOI. This echoes Cummins' "threshold hypothesis," which argues that additive bilingualism is best achieved when students' L2 proficiency has developed to a threshold level (Cummins & Swain, 1986). Second, it is too general to discuss the effect of MOI without referring to specific subjects of learning. Usually, the effects of MOI on learning outcomes are investigated in relation to certain subjects such as Integrated Science, Mathematics, History, Geography, etc. (Marsh, Hau, & Kong, 2000). For instance, Mathematics is less language-loaded whereas social science subjects are more language-loaded. Thus, the impact of MOI might vary according to the language loading of different subject areas.

Various studies have been done to understand the impact of MOI in local educational settings (e.g., Brimer, 1985; Chan, Johnson, & Hoare, 1996; Ip Tsang & Chan, 1985; Johnson, Chan, Lee, & Ho, 1985; N. K. Lo et al., 1998; Marsh et al., 2000; Siu et al., 1979). Of these studies, we will focus on several systematic research studies that provide solid evidence to show the association between the MOI and learning outcomes. These empirical studies share a common concern for the important issue of effective use of MOI for better learning in Hong Kong settings. In particular, the four studies initiated by the Education Research Establishment of the Education Department were conducted in the period when the language policy and MOI policy were being formulated. They played a significant role in providing direction for the formulation of the MOI policy in Hong Kong.

Siu et al. (1979) conducted an experimental study focusing on the effect of instruction in English or Chinese on students' learning in Mathematics, Physics, and History. The sample involved students in Form 2 to Form 4 from 16 schools. Two variables were used for classifying the students into groups: student learning ability and bilingual exposure. Student learning ability was measured by students' SSPA results and three categories were used: high, medium, and low. There were four types of bilingual exposure: extensive use of English, moderate use of English, restricted use of English, and extensive use of Chinese. Students received one of the four combinations: Chinese/English in visual/verbal mode. Subsequent results of the attainment tests in the three subject areas (Mathematics, Physics, and History) indicated that EMI had a positive effect on English proficiency whereas CMI had a negative effect on students' proficiency in English. Moreover, different MOI produced comparable results for high-ability students. However, EMI had a negative effect on students' cognitive development whereas CMI yielded positive effects. The negative effect of EMI on cognitive development was particularly strong for the moderate- and low-ability students.

The implications of these findings appeared to be consistent with what were discussed in documents on the MOI issue. For students with low to moderate ability, CMI could help them learn better. English as an MOI should only be used with students with high English ability who have the competence and skills to learn without difficulty in English. Several essential questions remained unanswered; for example, the argument that high-ability students can learn well in L2 should be clarified. For instance, what is the meaning of "learning well"? Does that mean students can comprehend and express their ideas in L2 equally well as in the first language (L1)? How can we identify the level of students' ability that can be categorized as competent to learn well in L2?

In 1980–2000, the Education Research Establishment of the Education Department of the Hong Kong government initiated a number of studies on the effect of MOI on learning outcomes (Brimer, 1985; Ip Tsang & Chan; 1985; Johnson et al., 1985). These studies provided empirical bases for the Education Commission to formulate the MOI policy in *Education Commission Report No. 2*. Brief reviews of these studies are as follows.

The research conducted by Brimer (1985) was similar to that of Siu et al. (1979). It was an experimental study focusing on the effect of MOI on learning outcomes of 1,100 Form 2 students in 12 Anglo-Chinese and 3 Chinese Middle schools. There were four modes of MOI: (1) English; (2) English with Chinese glossary; (3) Chinese with English glossary; and (4) Chinese. The two criteria for grouping students were the same as in Siu et al.'s study except that the bilingual exposure was reduced to two categories: in Anglo-Chinese and Chinese Middle schools. There was also a delayed post-test which had three versions: (1) first part in English and the second in Chinese; (2) first part in Chinese and the second in English; and (3) Chinese only.

The results with the English post-test indicated that only students with high English ability benefited from instruction in English, with or without a glossary. Thus, this study suggested that only the upper language proficiency groups in English could profit from "English only" as an MOI (Brimer, 1985). On the other hand, the results with the Chinese post-test indicated that there was no relationship between students' Chinese proficiency levels and treatment. The interpretation of the findings was that mixed code may not be handicapping but it was the requirement to perform in English (tests) that hinders students' performance. Based on these findings, Brimer (1985) suggested that a policy which allowed somewhere around the top 30% of students with good English proficiency to pursue their studies through English would succeed in making those students effective in both the L2 and the subjects (p. 41). The major problems of the study were: how to define the "upper language proficiency groups"? How can we determine that it is the top 30% and not 20% or less? How can we define and prove whether the students can benefit from English as an MOI?

Johnson et al. (1985) conducted another study in Form 3 in Hong Kong's Anglo-Chinese secondary schools. Similar to the previous two studies, this study was also experimentally designed. The main difference was that it attempted to eliminate the interference of the MOI. Different MOI treatments were in video or print format. There were three types of MOI video modes: Cantonese, English, and bilingual. There were five types for print format: Chinese, English, Chinese with English glossary, English with Chinese glossary, and bilingual texts. Students were sampled from 11 Anglo-Chinese schools. Some took part in the video treatment whereas others took part in the print treatment. All students were required to take a post-test on the subject matter presented. Two versions of the same test were used: (1) first part in Chinese and second part in English; and (2) first part in English and second part in Chinese.

In the "video treatment" study, both Cantonese and bilingual modes were found to be superior to the English-only mode for those students from Anglo-Chinese schools. The findings indicated that the effect of both Cantonese and bilingual modes were comparable. Cantonese modes benefited students in handling Chinese questions whereas bilingual modes benefited students in handling the English version. The bilingual mode was superior to the English-only mode in helping students to handle English questions. These findings seemed to suggest that the English mode of instruction might not be a good option for Anglo-Chinese schools as compared with other modes in the grade level of Secondary 3 (Grade 9). Similar results were obtained in the "print treatment" study. Performance on the Chinese questions was higher than those on English questions. Again, the low-proficiency students performed poorly in English questions but quite good in Chinese questions.

Ip Tsang and Chan's (1985) study was a survey rather than an experimental study. This study investigated (1) the relation between MOI and students' performance, and (2) students' as well as teachers' perceptions on the modes of MOI in their schools. A sample of 7,500 students in Form 1 to Form 3 from 15 Anglo-Chinese schools was included in the study. These schools were selected for the study according to their intake as indicated by SSPA. Three groups of schools were defined according to the banding of student intake: (1) mainly Bands 1 and 2; (2) Bands 2 to 4 (schools were not pure Band 2 or 3 but a mix); and (3) Bands 4 and 5. Another criterion was their MOI: (1) mainly English; (2) half English and half Chinese; and (3) mainly Chinese. Students' performance in Chinese, English, Mathematics, Science, and History were measured at the end of the school year from 1983 to 1985. With the exception of English and Chinese, three versions of the same test were used for the other three subjects. These versions included: English, bilingual, and Chinese. Finally, questionnaires were used to gather information about students' and teachers' perceptions on the modes of MOI.

Regarding students' achievement in relation to MOI, the findings suggested that students' English proficiency levels had strong and positive association with their performance in Mathematics, Science, and History, regardless of the versions of tests taken. On the other hand, students with low English ability performed less satisfactorily than their counterparts. The performance was worse if they took the English version of the test.

The results of the survey indicated that there were increases in the use of Cantonese for classroom instruction. It was found that students had many difficulties in coping with the English text as well as the use of English in the classroom. That was not a surprise as some teachers used more and more Cantonese to supplement their instruction. In fact, the results indicated that the exposure to English in instruction depended on students' and teachers' English ability.

M. F. Lo, Chan, and Ip Tsang (1985) extended Ip Tsang and Chan's (1985) previous study to include Chinese Middle schools. Their design and measures were very similar. A sample of 14,111 students in Form 1 to Form 3 was selected from 25 schools (20 Anglo-Chinese schools and 5 Chinese Middle schools). Again, their achievement in Chinese, English, Mathematics, Science, and History were measured at the end of the school years during 1983 to 1985. With the exception of English and Chinese, three versions of the same test were used for the other three subjects. These versions included: English, bilingual, and Chinese. The findings indicated that students from Anglo-Chinese schools performed better in English proficiency tests but those from Chinese Middle schools performed better in Chinese proficiency and history tests. There were no significant differences in performance in Mathematics and Science between the students in the two types of schools. The performance of students from Anglo-Chinese schools was the poorest when the English-version test was used. The data collected indicated that there were different extents to which a mixed code of instruction was used in Anglo-Chinese schools. Thus, the differences in performance between the two types of schools should not be interpreted as the instruction in Chinese being more effective than that in English.

The study by Marsh et al. (2000) examined how instruction in L1 (Chinese) and in L2 (English) affects high school students' achievement in four non-language subjects (Mathematics, Science, Geography, and History). The sample consisted of 12,784 secondary school students in Grade 7 attending any one of the 56 sampled Hong Kong high schools. Stratified sampling was used according to religious background, mode of government subsidy, gender grouping, and language of instruction. Multilevel growth modeling was used to examine the effects of the language of instruction on achievement during the first three years of high school after controlling for initial differences in student achievement.

The results indicated that first, the effects of instruction in English varied substantially for different school subjects. In particular, the effects were positive for the two language subjects — Chinese and English. However, the effects were negative for the non-language subjects — Mathematics, History, Geography, and Science. Second, these effects appeared to be reasonably stable over time. Results from the multilevel analysis indicated that the effects of MOI did not vary substantially overtime. The reduction in the negative effect over time was not substantial in all the four non-language subjects.

Marsh et al. (2000) summarized that Hong Kong high school students' were very disadvantaged by instruction in English in Geography, History, and Science, and to a lesser extent in Mathematics at junior high level. The size of this disadvantage was smaller for students who initially had better English-language skills. Overall, the effect of the late immersion program of the Hong Kong case was negative in non-language subjects although a small positive effect was found in L1 and L2 achievement. As Hakuta, Butler, and Witt (2000) suggested, comprehension of abstract concepts in non-language subjects, such as social studies and science, requires a high level of language fluency in the language of instruction even though the focus of the subjects is not language per se. Therefore, it may not be possible for students to gain benefits from a late immersion program unless they have already achieved a high threshold of functional L2 competence prior to the immersion. Table 2 displays the major findings of these MOI studies in Hong Kong.

These studies attempted to address the issue of effective use and appropriate choice of MOI in secondary schools in Hong Kong. Despite the differences in their designs, they provided similar findings for formulating the MOI and language policy in Hong Kong.

The consistent findings are listed below:

1. Only students with high ability can benefit from having only the L2 (English) as the MOI;

Table 2. Summary of the Major Findings of MOI Studies in Hong Kong

Study	Researched	Major findings and implications
Siu et al. (1979)	Forms 2–6; 16 schools with different extent in using English and Chinese as MOI in video and print form	1. EMI was found to have positive effect on English proficiency whereas CMI had negative effect on English proficiency; 2. EMI had negative effect on students' cognitive development, and this detrimental effect was stronger for moderate- and low-ability students; 3. English as MOI should be used only with students who have the competence and skills to learn, think, and communicate without difficulty in English.
Brimer (1985)	Form 2 only; 12 Anglo-Chinese and 3 Chinese Middle schools	1. In this six-week experimental study, Brimer found that only the upper language proficiency groups in English could benefit from "English only" as an MOI; 2. A policy which allowed somewhere around the top 30% of students in English proficiency to pursue their studies through English would succeed in making those students effective in both English and their curriculum (Brimer, 1985, p. 41).
Johnson et al. (1985)	Form 3 only; 11 Anglo-Chinese schools	1. In the "video treatment" study, both Cantonese and bilingual modes were found superior to the English-only mode for those students from Anglo-Chinese schools; 2. Similar results were obtained in the "print treatment" study. Performance on the Chinese questions was higher than those on English questions. Again, the low proficiency students performed poorly in English questions but were quite good in the Chinese questions.
Ip Tsang & Chan (1985)	Forms 1–3; 15 Anglo-Chinese schools	1. This survey study found that mixed mode of MOI was the predominant mode in use in the 15 Anglo-Chinese schools; 2. Students' English proficiency levels had strong and positive association with their performance in Mathematics, Science, and History, regardless of the version of tests taken;

Table 2 (Cont'd)

Study	Researched	Major findings and implications
		3. Students of high English proficiency performed equally well in both English and bilingual test papers but not so well in Chinese papers; however, the performance of students with low English proficiency was poor.
M. F. Lo et al. (1985)	Forms 1–3; 20 Anglo-Chinese schools and 5 Chinese Middle schools	1. Results from this survey study suggested that students from Anglo-Chinese schools performed better in English proficiency test but those from Chinese Middle schools performed better in Chinese proficiency and history tests; 2. There were no significant differences in performance in Mathematics and Science between the students in the two types of schools; 3. While comparing the two groups of students who were tested in Chinese and English, they found that performance of students was the poorest when the English-version paper was used. Such poor performances were consistent across subjects and forms.
Marsh et al. (2000)	Form 1; 56 Hong Kong high schools	1. The effects of instruction in English were positive for the two language subjects — Chinese and English; however, the effects were negative for the non-language subjects — Mathematics, History, Geography, and Science; 2. These effects appeared to be reasonably stable over time. The effects of MOI did not vary substantially over time. The reduction in the negative effect over time was not substantial in all the four non-language subjects; 3. Hong Kong high school students' were very disadvantaged by instruction in English in Geography, History, and Science, and to a lesser extent in Mathematics at junior high level; 4. Overall, the effect of the late immersion program in the case of Hong Kong was negative in non-language subjects although a small positive effect was found in L1 and L2 achievement.

2. Students with moderate or low ability underperform if they are required to use English as MOI;
3. A dominant portion of students have difficulty using English as MOI and their teachers have to make use of mixed code as a compromise.

In sum, we have reviewed the issue of MOI from two perspectives: the social and historical context, and the functional aspect of language in learning and instruction. The language and MOI policy, like any other policy, is a social product. We cannot underestimate the effect of social and political forces in formulating the language policy. For instance, English has enjoyed a long history of prestigious status in Hong Kong. Chinese as an MOI is usually stigmatized as a secondary choice. Furthermore, unlike Singapore, Malaysia, and India where English is usually the common language among people of different ethnic and cultural groups, Hong Kong has a diglossic environment in which English-speaking people and Chinese-speaking people generally belong to different communities and sometimes they do not have much chance to interact with one another. Under these circumstances, allocating students to an EMI or CMI environment without taking these social, economic, and political factors into consideration would not be adequate.

Research Design and Research Questions

Research Design of HK-PISA Main Study

The HK-PISA 2000+ main study was conducted in January to February 2002. A two-stage stratified sampling design was used. In the first stage, a random sample of schools from each stratum

Table 3. Distribution of Schools Which Participated in the HK-PISA 2000+ Main Study

Type of schools	Government	Aided	Independent
EMI	5 + 1 = 6	36	0
CMI-High	2	10	0
CMI-Medium	2	44	2
CMI-Low	3	29	4
International	0	0	2
Total	13	119	8

was selected with probability proportional to size. For Hong Kong, schools were classified into three strata: government, aided, and independent. The distribution of schools is shown in Table 3. The weighted school participation rate before replacement was 66.6%. After replacement, the weighted school participation rate was 92.6%. Hong Kong followed the OECD sampling procedures closely and the main study met the criteria for acceptable response rate.

Sampling

Table 3 shows the number of schools which participated in the main study. Schools were selected with the assistance of the then Education Department (now renamed as the Education and Manpower Bureau). Stratified sampling was used and the sample represents different types of schools (government, aided, and independent), different student intake (high, medium, and low as demonstrated in standardized attainment tests), and different MOI (EMI and CMI).

Language Tested

For the present PISA study, OECD suggested that the test language should be consistent with the MOI of the participating countries. According to OECD, students in EMI schools should be tested in English. However, in the context of Hong Kong, students' ethnic and linguistic environments are very homogenous. Chinese is the dominant ethnic background and written language for most students. Previous reading literacy studies in Hong Kong (Johnson & Cheung, 1995) used Chinese as the test language for international comparison. The rationale is that Chinese is the dominant language of Hong Kong society and the education system. English is only the second language and the linguistic environment is very homogenous using Chinese. Previous international studies in Mathematics and Science such as TIMSS (Third International Mathematics and Science Study) is bilingual. The rationale is that the MOI in school is usually bilingual and some of the schools use Chinese textbooks and some use English textbooks. Chinese (L1) was finally approved as the legitimate test language to be used in the HK-PISA international study.

In the main study of the HK-PISA 2000+, the research team attempted to examine the differences of students' performance in using L1 (Chinese) and L2 (English). The research team finally decided to use two versions of booklets (both English and Chinese) in assessing students in EMI schools. There were 28 schools which did both Chinese and English versions of the test.

Research Questions

In this article, we will examine the following questions:

1. Does the test language hinder students' performance?

2. Are there any differences in the performance of students from different types of schools as defined by the present MOI policy?
3. Are there any differences in the cognitive and non-cognitive learning outcomes from different types of schools as defined by the present MOI policy?
4. If so, are these differences related to student intake?

The first question is the other side of the coin about who can benefit from instruction in English. It is important to evaluate whether students are able to use English competently for learning after having been instructed in English. The other questions tell us whether the present MOI policy has any good or bad impact on students in terms of their cognitive and affective learning outcomes.

Results and Discussion

Comparing Levels of Literacy in Chinese Booklets and English Booklets

To address the first research question: "Does the test language hinder students' performance?", this section is organized into three parts: first, levels of literacy in the Chinese Booklets and English Booklets are compared by using all the student data from the total 167 schools which participated in the HK-PISA in 2002. Then, we select only the EMI schools (28 of them) which conducted the tests in both Chinese and English for comparing the levels of literacy. Finally, we compare each of the 28 schools to examine if we can identify some schools where the L2 does not hinder students' literacy performance.

Table 4 shows the literacy level of 15-year-old students in reading, mathematics, and science measured by the Chinese and the English booklets. The average percentage scores of reading were 62.15 for those using the Chinese version and 48.57 for those using the English version. The average percentage scores of mathematics were 55.76 for those using the Chinese version and 62.20 for those using the English version. The average percentage scores of science were 54.21 for those using the Chinese version and 45.48 for those using the English version. These figures show that students were disadvantaged when using English as a test language as opposed to using Chinese in reading and science.

Table 4. Students' Literacy in Reading, Mathematics, and Science: Comparison of the Results Tested in Chinese and English (*N* = 167 schools)

Subjects	Test Language				*F*-value	*p*-value
	Chinese		English			
	M	*SD*	*M*	*SD*		
Reading	62.15 (*n* = 4880)	17.92	48.57 (*n* = 1304)	17.84	592.271	.000
Mathematics	55.76 (*n* = 2702)	21.90	62.20 (*n* = 724)	19.71	51.474	.000
Science	54.21 (*n* = 2703)	21.02	45.48 (*n* = 728)	19.74	101.485	.000

Note: *n* represents the number of students.

In the next analysis, we selected students from the 28 EMI schools and we compared the students' performance using the two test languages. The result in Table 5 indicated that students performed significantly better when being tested in the Chinese version than in the English version in all the three domains. The differences are quite large in reading and science. The difference

Table 5. Students' Literacy in Reading, Mathematics, and Science: Comparison of the Results Tested in Chinese and English (N = 28 EMI schools)

Subjects	Test Language				F-value	p-value
	Chinese		English			
	M	SD	M	SD		
Reading	73.65 (n = 917)	11.64	48.68 (n = 925)	16.74	1379.049	.000
Mathematics	69.65 (n = 508)	16.02	63.43 (n = 515)	18.49	33.095	.000
Science	66.59 (n = 515)	16.53	45.84 (n = 512)	19.47	338.934	.000

Note: n represents the number of students.

in mathematics is relatively smaller. Students from EMI schools should have attained similar literacy levels with both Chinese and English versions. However, results from the study indicated that the actual performance might be much lower than what the policy makers expected.

To have a more detailed comparison, we will focus on the 28 EMI schools tested in both languages in the next analysis. Table 6 shows the comparisons in each of these schools. These findings indicate that the performance of students using the two test languages differed significantly. Of the 28 schools, the average scores of reading and science were significantly better with the Chinese version than with the English version, with only one exception in science out of 28 schools. However, the average scores for mathematics in 5 schools were slightly better with the Chinese version than with the English version.

Since students taking the Chinese version and those taking the English version were from the same schools, their literacy

Table 6. Comparison of the Students' Literacy in Reading, Mathematics, and Science Measured in Chinese and in English (For the 28 EMI Schools Tested in Both Languages)

School ID*	Reading			Mathematics			Science		
	Chinese	English	*p*-value	Chinese	English	*p*-value	Chinese	English	*p*-value
001	79.19	55.19	.000	73.02	70.78	n.s.	72.08	47.57	.001
	(*n* 29)	(*n* 28)		(*n* 17)	(*n* 16)		(*n* 16)	(*n* 16)	
002	73.97	44.99	.000	72.55	58.82	.017	63.17	46.20	.004
	(*n* 33)	(*n* 35)		(*n* 17)	(*n* 20)		(*n* 18)	(*n* 20)	
003	76.01	55.79	.000	80.36	71.15	.036	70.70	51.31	.001
	(*n* 32)	(*n* 35)		(*n* 17)	(*n* 20)		(*n* 20)	(*n* 19)	
004	72.67	45.44	.000	67.65	65.43	n.s.	61.16	43.28	.014
	(*n* 35)	(*n* 35)		(*n* 19)	(*n* 20)		(*n* 20)	(*n* 19)	
005	75.44	47.83	.000	66.58	55.86	n.s.	72.68	52.54	.001
	(*n* 35)	(*n* 34)		(*n* 20)	(*n* 19)		(*n* 19)	(*n* 19)	
006	79.32	58.23	.000	69.91	59.01	.042	65.89	48.34	.004
	(*n* 35)	(*n* 35)		(*n* 20)	(*n* 19)		(*n* 19)	(*n* 20)	
007	72.34	47.13	.000	69.09	57.26	n.s.	62.34	38.46	.002
	(*n* 30)	(*n* 32)		(*n* 17)	(*n* 17)		(*n* 16)	(*n* 20)	
008	76.05	44.46	.000	62.63	59.94	n.s.	63.40	41.96	.002
	(*n* 34)	(*n* 34)		(*n* 18)	(*n* 19)		(*n* 19)	(*n* 19)	
009	69.38	46.79	.000	72.39	64.53	n.s.	63.63	48.51	.002
	(*n* 32)	(*n* 32)		(*n* 16)	(*n* 16)		(*n* 20)	(*n* 17)	
010	64.90	46.04	.000	63.83	59.34	n.s.	63.03	45.88	.020
	(*n* 29)	(*n* 30)		(*n* 16)	(*n* 17)		(*n* 17)	(*n* 15)	
011	72.82	40.77	.000	63.69	57.34	n.s.	72.79	36.71	.000
	(*n* 33)	(*n* 35)		(*n* 19)	(*n* 20)		(*n* 18)	(*n* 19)	
012	77.98	61.73	.000	78.04	74.22	n.s.	72.00	58.48	.028
	(*n* 28)	(*n* 31)		(*n* 14)	(*n* 17)		(*n* 17)	(*n* 17)	
013	66.03	40.12	.000	66.04	55.86	n.s.	55.42	32.66	.001
	(*n* 34)	(*n* 33)		(*n* 19)	(*n* 17)		(*n* 19)	(*n* 19)	

014	79.44	56.64	.000	75.65	73.83	n.s.	80.00	56.45	.000
	(*n* 34)	(*n* 34)		(*n* 18)	(*n* 20)		(*n* 20)	(*n* 18)	
015	76.17	55.78	.000	78.44	72.67	n.s.	66.18	55.13	.042
	(*n* 35)	(*n* 35)		(*n* 20)	(*n* 19)		(*n* 19)	(*n* 20)	
016	76.17	49.27	.000	69.37	64.14	n.s.	65.27	46.66	.002
	(*n* 34)	(*n* 34)		(*n* 19)	(*n* 18)		(*n* 19)	(*n* 20)	
017	71.55	37.05	.000	61.19	60.60	n.s.	66.71	30.89	.000
	(*n* 30)	(*n* 31)		(*n* 17)	(*n* 18)		(*n* 14)	(*n* 16)	
018	68.51	43.86	.000	68.19	60.59	n.s.	61.28	48.61	.012
	(*n* 34)	(*n* 35)		(*n* 19)	(*n* 20)		(*n* 19)	(*n* 19)	
019	71.80	43.56	.000	69.76	67.90	n.s.	66.14	38.07	.000
	(*n* 33)	(*n* 33)		(*n* 20)	(*n* 20)		(*n* 18)	(*n* 18)	
020	72.99	52.00	.000	75.51	53.62	.000	63.31	41.06	.001
	(*n* 33)	(*n* 30)		(*n* 20)	(*n* 16)		(*n* 17)	(*n* 17)	
021	76.97	59.70	.000	71.08	66.64	n.s.	68.02	56.57	n.s.
	(*n* 31)	(*n* 35)		(*n* 18)	(*n* 19)		(*n* 17)	(*n* 20)	
022	73.38	50.71	.000	64.24	57.94	n.s.	62.69	46.00	.001
	(*n* 35)	(*n* 35)		(*n* 19)	(*n* 20)		(*n* 20)	(*n* 19)	
023	70.58	39.78	.000	63.00	59.97	n.s.	62.06	34.75	.000
	(*n* 32)	(*n* 33)		(*n* 16)	(*n* 18)		(*n* 19)	(*n* 18)	
024	74.39	50.01	.000	74.17	67.62	n.s.	68.96	52.13	.006
	(*n* 29)	(*n* 26)		(*n* 17)	(*n* 14)		(*n* 17)	(*n* 15)	
025	71.69	42.78	.000	64.64	64.70	n.s.	66.52	45.07	.001
	(*n* 35)	(*n* 31)		(*n* 19)	(*n* 17)		(*n* 20)	(*n* 16)	
026	69.62	43.00	.000	63.03	58.48	n.s.	60.57	35.96	.000
	(*n* 35)	(*n* 34)		(*n* 20)	(*n* 19)		(*n* 19)	(*n* 19)	
027	75.37	49.29	.000	70.12	69.89	n.s.	74.78	48.19	.000
	(*n* 34)	(*n* 35)		(*n* 19)	(*n* 20)		(*n* 20)	(*n* 19)	
028	77.40	54.67	.000	78.25	66.94	.011	73.58	55.06	.000
	(*n* 34)	(*n* 35)		(*n* 18)	(*n* 20)		(*n* 19)	(*n* 19)	

* To keep anonymity of school identity, these are pseudo-IDs.

Note: *n* represents the number of students.

levels should have been comparable. This result indicates that the actual competence in reading, mathematics, and science might have been underestimated when the students were being tested in an L2. As pointed out by Cummins (1989), being tested in an L2 often does not reflect the students' true ability, and may result in unfairness. The L2 may be a major barrier for most students (even in EMI schools) to understand the text, to interpret the content, and to express their ideas and answers. Our L1, Chinese, was used as the test language for international comparison except for those English native-speakers in international schools. Since the results of the assessment in Chinese and English are so different, the coming analysis will focus on the results from the Chinese version only.

Comparing Cognitive Performance of Schools Segregated by MOI and Tracking Policy

To answer the second research question: "Are there any differences in the performance of students from different types of schools as defined by the present MOI policy?", we focus on two types of performance: cognitive and non-cognitive performance. Cognitive performance includes reading, mathematics, and science literacy performance. Non-cognitive performance includes students' self-concept and interest in learning Chinese and Mathematics.

Table 7 shows the students' performance from five types of schools: EMI schools, CMI schools with high, medium and low student prior ability, and international schools.[1] Results indicate that student's prior ability is significantly related to the

Table 7. Students' Literacy in Reading, Mathematics, and Science: Comparison of the Results in Different Types of Schools (For Participating Schools Accepted by OECD)

	EMI (Chinese)	CMI-High (Chinese)	CMI-Medium (Chinese)	CMI-Low (Chinese)	EMI (English)	Inter-national (English)
Reading						
M	73.69	70.10	61.12	46.81	48.57	66.54
	(*n* 1346)	(*n* 366)	(*n* 1518)	(*n* 1079)	(*n* 1304)	(*n* 57)
SD	11.27	11.58	15.10	18.21	17.84	22.34
Mathematics						
M	70.25	63.42	53.83	37.88	62.2	63.95
	(*n* 746)	(*n* 203)	(*n* 844)	(*n* 590)	(*n* 724)	(*n* 30)
SD	15.91	17.16	19.09	20.06	19.71	22.71
Science						
M	66.86	62.84	52.12	38.60	45.48	58.54
	(*n* 750)	(*n* 207)	(*n* 832)	(*n* 595)	(*n* 728)	(*n* 32)
SD	16.80	15.81	19.01	18.68	19.74	21.03

Note: *n* represents the number of students. Only one EMI school with low student intake participated in our main study. As Chinese is not the L1 of these students who speak other languages such as Hindi or Pakistani, English was used as their test language. The results are: Reading: 32.91 (n = 29, SD = 19.49); Mathematics: 19.42 (n = 17, SD = 15.23); Science: 26.58 (n = 17, SD = 12.63).

average performance of students in this test. The average percentage scores of students in EMI schools have the highest scores in all three domains. Of the 21 CMI schools, schools which have high-ability students perform better than those with medium ability and low ability. This pattern is consistent with many previous local studies (e.g., Johnson & Cheung, 1995; N. K. Lo et al., 1998).

Within the CMI category, the mean values become smaller and smaller from High through Medium to Low. For instance, the mean Reading score of CMI-High, CMI-Medium, and CMI-Low are 70.10, 61.12, and 46.81 respectively. Similar patterns are found in Mathematics and Science. In the three subjects, students from EMI schools, when tested in Chinese, have the highest mean scores. They outperform those from other types of school.

Comparison of Non-cognitive Outcomes of Schools Segregated by MOI and Tracking Policy

This section focuses on aspects including students' interest in learning and self-concept. The differences in these aspects between CMI and EMI schools are examined. These schools can be divided further according to their student intake. The five types are EMI, CMI-High, CMI-Medium, CMI-Low, and international schools.[2]

Five indices of non-cognitive outcomes are used in PISA. They are students' interest in mathematics, interest in reading, and self-concept in mathematics, reading, and academic learning in general.

OECD standardized the indices with a mean of 0 and standard deviation of 1. Positive values indicate that the students responded more positively than all students did on average across OECD countries to the relevant items whereas negative indicated the reverse. From Table 8, the positive values indicated that Hong Kong students are interested in both mathematics and reading. In contrast, the students have relatively low self-concepts in mathematics, reading, and academic learning. Most of the mean values of the self-concept are negative. If international schools were excluded, there is clearly a trend of decreasing values from left to right (i.e., EMI to CMI-High and then CMI-Medium and CMI-Low). For example, EMI has

Table 8. Summary Table for the Mean Estimates of the Index in Non-cognitive Learning Outcomes

	EMI	CMI-High	CMI-Medium	CMI-Low	Inter-national
Index of interest in mathematics (INTMAT)	0.8523 (0.027)	0.5817 (0.080)	0.5207 (0.038)	0.3133 (0.051)	0.2420 (0.117)
Index of interest in reading (INTREA)	0.5348 (0.025)	0.3717 (0.066)	0.2502 (0.023)	0.1773 (0.028)	0.2169 (0.241)
Index of self-concept in mathematics (MATCON)	0.0949 (0.027)	−0.0483 (0.069)	−0.1028 (0.038)	−0.1817 (0.038)	0.0938 (0.064)
Index of self-concept in academic learning (SCACAD)	−0.4069 (0.034)	−0.4688 (0.073)	−0.5547 (0.035)	−0.5961 (0.036)	−0.0202 (0.371)
Index of self-concept in reading (SCVERB)	−0.2457 (0.029)	−0.2808 (0.054)	−0.2965 (0.025)	−0.3844 (0.029)	−0.2843 (0.223)

Note: Figures in parentheses represent the standard error of mean estimate.

a mean of 0.8523 in the interest in mathematics, CMI-High has only 0.5817 and CMI-Low is even lower. The differences in values among these types of schools are substantial.

Interest in Mathematics and Reading

Tables 9–13 are a summary of the multiple comparisons of mean by school types with different MOI and academic ability.

CMI-Low schools also have the lowest scores in the index of reading interest. They are significantly lower than EMI and CMI-High schools but have no significant difference with CMI-Medium schools. Students from international schools seem not to have any significant difference with other types of schools (see Table 9).

Table 9. Index of Interest in Reading (INTREA)

	M	*SE*	EMI	CMI-High	CMI-Medium	CMI-Low	International
EMI	0.5348	0.03	—	▲	▲▲▲	▲▲▲	○
CMI-High	0.3717	0.07	▽	—	○	▲▲	○
CMI-Medium	0.2502	0.02	▽▽▽	○	—	○	○
CMI-Low	0.1773	0.03	▽▽▽	▽▽	○	—	○
International	0.2169	0.24	○	○	○	○	—

Note: Read across the row for one stratum to compare performance with the stratum listed along the top of the table. "▽" indicates that the mean estimate of the stratum in the row is significantly lower than that in the column (▽, at $p < .05$ level; ▽▽, at $p < .01$ level; ▽▽▽, at $p < .001$ level) whereas "▲" indicates significantly higher than that in the column (▲, at $p < .05$ level; ▲▲, at $p < .01$ level; ▲▲▲, at $p < .001$ level). "○" indicates that there is no statistically significant difference between them.

In general, EMI schools have the highest mean value in the index of interest in mathematics, which is significantly higher than other types of schools. In contrast, international schools have a significantly smaller value than EMI, CMI-High, and CMI-Medium schools. No significant difference can be found in CMI-Low schools and international schools. In other words, even students in international schools have very low interest in learning mathematics, which is comparable to the CMI-Low schools (see Table 10).

Self-concept in Academic Learning, Reading, and Mathematics

The index of self-concept in academic learning was derived from students' level of agreement with the following statements: "I learn things quickly in most school subjects; I am good at most school subjects; and I do well in tests in most school subjects."

Table 10. Index of Interest in Mathematics (INTMAT)

	M	*SE*	EMI	CMI-High	CMI-Medium	CMI-Low	International
EMI	0.8523	0.03	—	▲▲	▲▲▲	▲▲▲	▲▲▲
CMI-High	0.5817	0.08	▽▽	—	○	▲▲	▲
CMI-Medium	0.5207	0.04	▽▽▽	○	—	▲▲▲	▲
CMI-Low	0.3133	0.05	▽▽▽	▽▽	▽▽▽	—	○
International	0.2420	0.12	▽▽▽	▽	▽	○	—

Note: Read across the row for one stratum to compare performance with the stratum listed along the top of the table. "▽" indicates that the mean estimate of the stratum in the row is significantly lower than that in the column (▽, at $p < .05$ level; ▽▽, at $p < .01$ level; ▽▽▽, at $p < .001$ level) whereas "▲" indicates significantly higher than that in the column (▲, at $p < .05$ level; ▲▲, at $p < .01$ level; ▲▲▲, at $p < .001$ level). "○" indicates that there is no statistically significant difference between them.

Table 11. Index of Self-concept in Academic Learning (SCACAD)

	M	*SE*	EMI	CMI-High	CMI-Medium	CMI-Low	International
EMI	−0.4069	0.03	—	○	▲▲	▲▲▲	○
CMI-High	−0.4688	0.07	○	—	○	○	○
CMI-Medium	−0.5547	0.04	▽▽	○	—	○	○
CMI-Low	−0.5961	0.04	▽▽▽	○	○	—	○
International	−0.0202	0.37	○	○	○	○	—

Note: Read across the row for one stratum to compare performance with the stratum listed along the top of the table. "▽" indicates that the mean estimate of the stratum in the row is significantly lower than that in the column (▽, at $p < .05$ level; ▽▽, at $p < .01$ level; ▽▽▽, at $p < .001$ level) whereas "▲" indicates significantly higher than that in the column (▲, at $p < .05$ level; ▲▲, at $p < .01$ level; ▲▲▲, at $p < .001$ level). "○" indicates that there is no statistically significant difference between them.

Students from all types of schools have negative values in the index of self-concept in academic learning. International schools have the highest mean value in the index. But they are not significantly higher than other types of schools. EMI schools have significantly higher scores than CMI-Medium and CMI-Low schools (see Table 11).

The index of self-concept in reading was derived from students' level of agreement with the following statements: "I'm hopeless in <the test language>; I learn things quickly in <the test language>; and I get good marks in <the test language>."

All students have negative mean scores in the index of self-concept in reading. EMI schools have the highest scores and they are significantly higher than CMI-Low schools. Students from CMI-Low schools have the lowest mean value of the index, which are significantly lower than all EMI schools and CMI-Medium schools but they have no significant differences with CMI-High and international schools (see Table 12).

The index of self-concept in mathematics was derived from students' level of agreement with the following statements: "I get good marks in mathematics; mathematics is one of my best subjects; and I have always done well in mathematics."

Students from the EMI and international schools have positive values in the index of self-concept in mathematics. But all the CMI schools have negative values. EMI schools are significantly higher than all the CMI schools but have no significant differences with international schools. Students from CMI-Low schools have the lowest value in the index, which are significantly lower than EMI and international schools (see Table 13).

In sum, the interest in reading and mathematics appears to be significantly higher for students from EMI schools. Although the CMI schools and international schools have relatively lower

Table 12. Index of Self-concept in Reading (SCVERB)

	M	*SE*	EMI	CMI-High	CMI-Medium	CMI-Low	International
EMI	−0.2457	0.03	—	○	○	▲▲▲	○
CMI-High	−0.2808	0.05	○	—	○	○	○
CMI-Medium	−0.2965	0.03	○	○	—	▲	○
CMI-Low	−0.3844	0.03	▽▽▽	○	▽	—	○
International	−0.2843	0.22	○	○	○	○	—

Note: Read across the row for one stratum to compare performance with the stratum listed along the top of the table. "▽" indicates that the mean estimate of the stratum in the row is significantly lower than that in the column (▽, at $p < .05$ level; ▽▽, at $p < .01$ level; ▽▽▽, at $p < .001$ level) whereas "▲" indicates significantly higher than that in the column (▲, at $p < .05$ level; ▲▲, at $p < .01$ level; ▲▲▲, at $p < .001$ level). "○" indicates that there is no statistically significant difference between them.

Table 13. Index of Self-concept in Mathematics (MATCON)

	M	*SE*	EMI	CMI-High	CMI-Medium	CMI-Low	International
EMI	0.0949	0.03	—	▲	▲▲▲	▲▲▲	○
CMI-High	−0.0483	0.07	▽	—	○	○	○
CMI-Medium	−0.1028	0.04	▽▽▽	○	—	○	▽▽
CMI-Low	−0.1817	0.04	▽▽▽	○	○	—	▽▽▽
International	0.0938	0.06	○	○	▲▲	▲▲▲	—

Note: Read across the row for one stratum to compare performance with the stratum listed along the top of the table. "▽" indicates that the mean estimate of the stratum in the row is significantly lower than that in the column (▽, at $p < .05$ level; ▽▽, at $p < .01$ level; ▽▽▽, at $p < .001$ level) whereas "▲" indicates significantly higher than that in the column (▲, at $p < .05$ level; ▲▲, at $p < .01$ level; ▲▲▲, at $p < .001$ level). "○" indicates that there is no statistically significant difference between them.

interest in reading and mathematics, the index is still higher than the OECD average. For the three indices of self-concept, Hong Kong students consistently have much lower self-concept in reading, mathematics, and general academic learning than the OECD average regardless of the school types.

The Effects of EMI Schools on Reading Literacy

In the following HLM analysis, international schools are excluded because there are only two international schools in the HK-PISA sample. Model 1 of Table 14 is a direct comparison between EMI, CMI-High, CMI-Medium, and CMI-Low schools. EMI schools were used as the reference dummy variable.

The results in Model 1 of Table 14 suggest that students from EMI schools have reading scores significantly higher than that of the three types of CMI schools. The coefficients suggest that CMI-High schools have an average of 18-point score lower than EMI schools; CMI-Medium schools have a 57-point score

Table 14. Comparison of Reading Literacy of EMI and CMI Schools

Reading Literacy	Model 1		Model 2	
	Coefficient	*SE*	Coefficient	*SE*
Adjusted school mean	528.62	2.03	534.51	1.95
Effect of school-level factors				
School mean AAI	—		1.05*	0.45
CMI-High	–17.77***	5.24	9.76	5.70
CMI-Medium	–56.76***	4.47	7.60	7.32
CMI-Low	–122.41***	5.99	1.18	13.1
Effect of student-level factors				
AAI			2.80***	.18
Final estimation of variance component				
Between schools	362.55***		160.46***	
Within schools	3736.86		3393.65	
Percentage of variance explained				
Between schools	86.10%		93.86%	
Within schools	0%		9.06%	

*** $p < .001$; ** $p < .01$; * $p < .05$

lower than EMI schools; and CMI-Low schools have a 122-point score lower than EMI schools.

Model 2 of Table 14 examines whether the advantage of EMI schools still exists after controlling for student intake. The coefficients shown in the model are net effects — i.e., the effect of the variable after taking the effects of student intake into account. Therefore, coefficients in Model 1 can be seen as unadjusted scores. Model 2 is the adjusted scores after controlling for student intake.

Model 2 indicates that both student-level AAI and school mean AAI have significant effect on students' literacy performance. After taking student and school intake into account, the advantage of EMI schools disappears. What these data show, then, is that when adequate control is exercised for student intake, the initial significant differences between EMI and CMI schools no longer exist.

Net Effect of EMI Schools on Mathematics and Science Achievement

The results in Model 1 of Table 15 suggest that students from EMI schools have mathematics scores significantly higher than that of CMI schools. The coefficients suggest that CMI-High schools have an average of 21-point score lower than EMI schools; CMI-Medium schools have a 65-point score lower than EMI schools; and CMI-Low schools have a 126-point score lower than EMI schools.

Model 2 of Table 15 indicates that both student-level AAI and school mean AAI have significant effect on students'

Table 15. Comparison of Mathematical Literacy of EMI and CMI Schools

Mathematical Literacy	Model 1		Model 2	
	Coefficient	*SE*	Coefficient	*SE*
Adjusted school mean	561.43	2.65	567.71	2.02
Effect of school-level factors				
School mean AAI	—		1.35*	0.57
CMI-High	–21.47**	8.22	11.49	7.17
CMI-Medium	–64.53***	5.39	14.31	9.21
CMI-Low	–125.69***	7.91	25.11	16.13
Effect of student-level factors				
AAI			3.43***	.28
Final estimation of variance component				
Between schools	468.70***		120.05***	
Within schools	5085.24		4558.31	
Percentage of variance explained				
Between schools	83.37%		95.74%	
Within schools	0%		9.96%	

*** $p < .001$; ** $p < .01$; * $p < .05$

mathematical literacy performance. After taking student and school intake into account, the advantage of EMI schools also disappears. In other words, the initial significant differences between EMI and CMI schools no longer exist when adequate control is exercised for student intake.

The results in Model 1 of Table 16 suggest that students from EMI schools have scientific literacy scores significantly higher than that of CMI schools. The coefficients suggest that CMI-High schools have an average of 16-point score lower than EMI schools; CMI-Medium schools have a 56-point score lower than EMI schools; and CMI-Low schools have a 117-point score lower than EMI schools.

Model 2 of Table 16 indicates that both student-level and school-level AAI have significant effect on students' scientific

Table 16. Comparison of Scientific Literacy of EMI and CMI Schools

Scientific Literacy	Model 1		Model 2	
	Coefficient	*SE*	Coefficient	*SE*
Adjusted school mean	540.65	2.18	547.23	2.02
Effect of school-level factors				
School mean AAI	—		0.23*	0.57
CMI-High	−16.15*	7.68	9.22	7.17
CMI-Medium	−56.22***	5.31	1.32	9.21
CMI-Low	−117.13***	5.91	−4.53	16.13
Effect of student-level factors				
AAI			3.27***	.28
Final estimation of variance component				
Between schools	273.17***		115.42***	
Within schools	4635.24		4182.48	
Percentage of variance explained				
Between schools	87.95%		94.96%	
Within schools	1.1%		9.87%	

*** $p < .001$; ** $p < .01$; * $p < .05$

literacy performance. After taking student and school intake into account, the advantage of EMI schools also disappears. This pattern is very consistent across the three subject domains. In other words, the initial significant differences in reading, mathematics, and science between EMI and CMI schools can be explained by student intake and the average school-level student intake.

Conclusions, Implications, and Recommendations

While comparing levels of literacy in the three domains tested in Chinese and English, we found that 15-year-old students' performance in reading and science are better with the Chinese test version than with the English test version. On the other hand, their performance in mathematics is better with the English test version than with the Chinese test version. In this comparison, only 1,304 students from EMI and international schools took the tests in English whereas a total of 4,480 students from EMI and CMI schools took the tests in Chinese. Therefore, we can argue that the advantage of assessment in Chinese is significant in reading and science but not evident in mathematics. One possible explanation is that the group of students tested in Chinese has lower ability on average than the group tested in English. Moreover, the language loading of mathematics is less demanding than in reading and writing. Therefore, we selected only EMI schools to examine if students in EMI schools can perform equally well in both the Chinese and English version of the test. Given similar high student intake in EMI schools, we found a consistent significant advantage of assessment in Chinese in reading, mathematics, and science. It appears that the 28 EMI schools as a whole cannot perform equally well in both L1 and L2. In the third analysis, we examine if there are some EMI schools with very high-ability students that can perform equally well in both Chinese and English. Since the students are from the same schools, they are similar in background and in ability levels. The results indicate that all the sampled EMI schools performed significantly better in Chinese in the reading and science test. For mathematics, five schools performed better when tested in Chinese and 23 schools performed equally well in both the Chinese test version and the English test version.

Regarding the non-cognitive learning outcomes, students from EMI schools have the highest interest in mathematics and reading than those from other types of schools. It is worth noting that all students have quite a low self-concept on the whole. However, students from international schools have a relative higher self-concept in academic learning. It seems that students from CMI-Low schools are most disadvantaged in terms of their interest and self-concept in learning.

Results from multilevel analysis indicate that the advantage of EMI schools in the reading, mathematics, and science achievement is significant without controlling for the student intake. Yet, the advantage of EMI schools disappears after the student intake factor had been taken into account.

Three implications can be drawn from these results. First, in high-language-loaded domains such as reading and science, students' performances are commonly underestimated when being assessed in English (L2). This is because they are less proficient in L2 than they are in L1. Secondly, it is really a concern that 15-year-old students in EMI schools cannot use English proficiently in examinations. However, the achievement gap between using L1 and L2 decreases substantially as the grade level increases (see Figures 1–3).

Researchers such as Cummins (1989) suggested that the achievement of additive bilingualism normally requires five to seven years of academic L2-medium education. Johnson (1997) even predicted that, by the end of Form 5, the English-medium students (selected for their ability and motivation) can catch up with their Chinese-medium counterparts.

Findings from the present study appears to support Johnson's (1997) prediction of the trend of reducing the achievement gap between the L1 and L2 as a test language. Yet the estimation of five years for overcoming the language

Figure 1. Achievement Gap in Reading Across Grade Levels

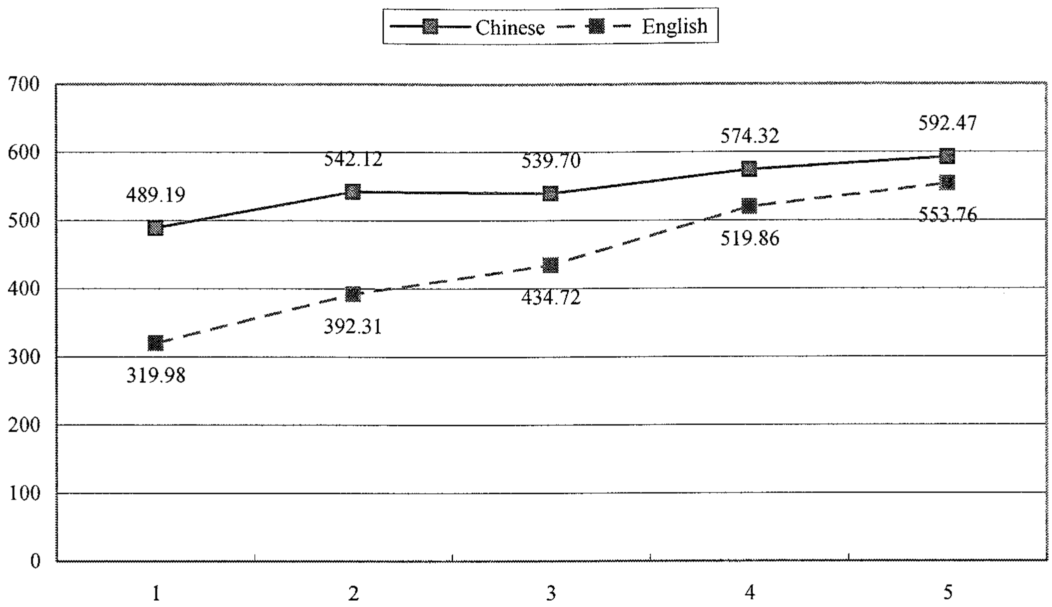


Figure 2. Achievement Gap in Mathematics Across Grade Levels

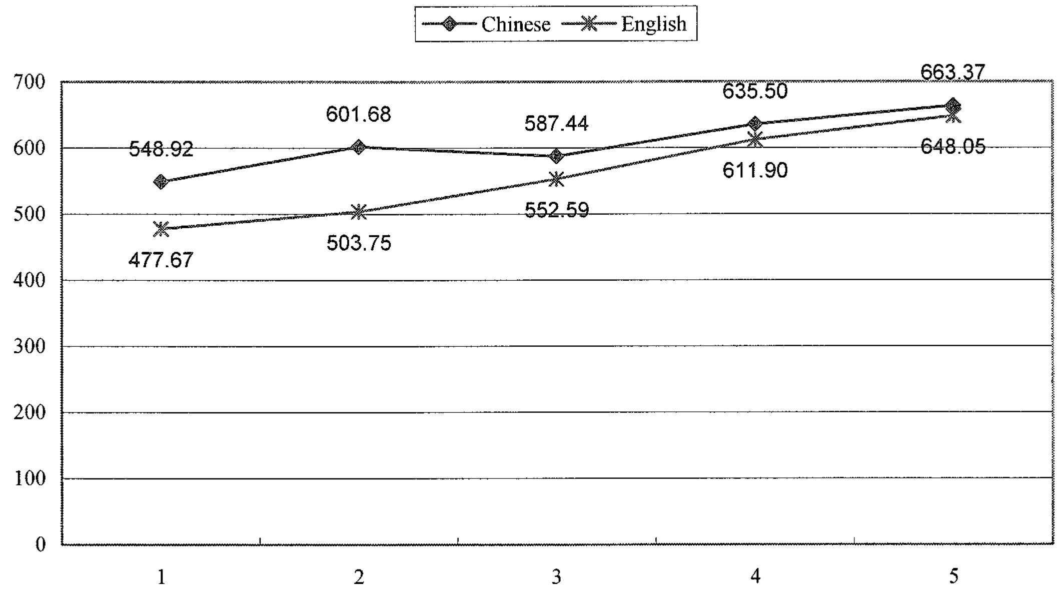
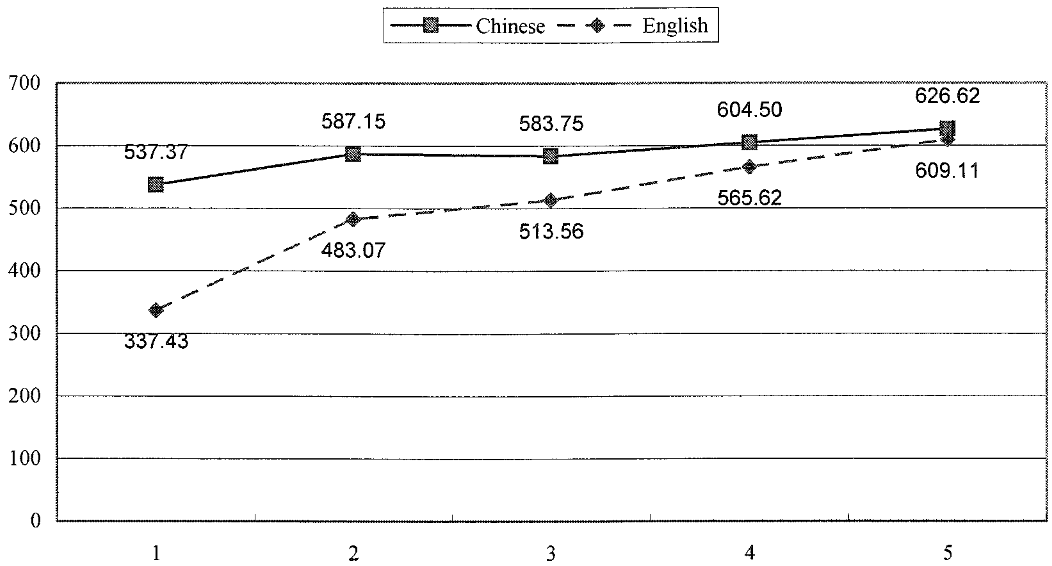


Figure 3. Achievement Gap in Science Across Grade Levels



barrier in learning might have underestimated the progress in different subject domains. As we can see in Table 17, for reading, significant differences still exist between testing in English and Chinese in Form 5 (Grade 11). For science and mathematics, the difference between testing in the two languages is not significant. Therefore, a comparison between EMI and CMI students would not be valid even if at least five years of education had been completed

Finally, results from HLM analysis suggest that the advantage of EMI schools is mainly because of the student intake. Given the same student intake, students in EMI schools would perform similarly to those in CMI schools. However, the non-cognitive outcomes such as self-concept and interest which are generally higher in EMI schools are noteworthy for further study.

Recommendations

For School Principals and Teachers

We recommend the close integration of language and content of teaching for reducing the achievement gap between L1 and L2. Often the achievement gap is further widened when a student is being tested in the two languages. The results indicate that students even in EMI schools seem not to be able to express their ideas in English as well as they do in Chinese, especially in lower form levels. The possible reasons are threefold: first, the "bridging time" of shifting from L1 to L2 in less than five years at the secondary level may not be enough for academic purposes when the English curriculum at the primary level is not as academically content-oriented as in the secondary level.

Table 17. Achievement Gap Between Chinese and English as Test Language by Grade

Grade	Domain	Test Language	*n*	*M*	*SD*	*F*	*p*
7	Reading	Chinese	21	489.19	52.43	37.66	0.000
		English	12	319.98	106.61		
	Mathematics	Chinese	16	548.92	58.60	2.62	0.121
		English	6	477.67	153.31		
	Science	Chinese	11	537.37	88.78	15.47	0.001
		English	6	337.43	119.73		
8	Reading	Chinese	41	542.12	46.46	75.43	0.000
		English	46	392.31	101.31		
	Mathematics	Chinese	21	601.68	87.95	9.46	0.004
		English	24	503.75	120.44		
	Science	Chinese	23	587.15	45.48	19.31	0.000
		English	24	483.07	104.45		
9	Reading	Chinese	79	539.70	76.95	55.56	0.000
		English	71	434.72	95.31		
	Mathematics	Chinese	42	587.44	89.65	2.86	0.094
		English	43	552.59	99.76		
	Science	Chinese	45	583.75	53.44	17.82	0.000
		English	46	513.56	98.22		
10	Reading	Chinese	615	574.32	51.39	199.50	0.000
		English	620	519.86	80.76		
	Mathematics	Chinese	341	635.50	78.18	12.48	0.000
		English	333	611.90	94.67		
	Science	Chinese	343	604.50	62.11	44.64	0.000
		English	340	565.62	87.88		
11	Reading	Chinese	161	592.47	42.75	43.98	0.000
		English	174	553.76	61.59		
	Mathematics	Chinese	88	663.37	78.14	1.25	0.266
		English	109	648.05	108.00		
	Science	Chinese	93	626.62	50.51	3.16	0.077
		English	95	609.11	80.68		

Research indicates that it takes at least 5–7 years for L2 learners to achieve academic grade norm levels as native speakers (Cummins, 1989). Cummins and Man (2007) further point to the importance of developing students' academic language in their L2 within a conversational/academic continuum when receiving an English-medium education.

It is also not just a matter of the number of years for additive bilingualism to be acquired; many other conditions have to be met as well (Lin & Man, 1999). Another concern is the time for entry to immersion. There is debate concerning the difference in cognitive and academic outcomes between early versus late immersion (see examples in Harley, Allen, Cummins, & Swain, 1990). A variety of models can actually work effectively under appropriate conditions (Cummins, 2003). The large achievement gap between using L1 and L2 for the present study might be related to the late immersion model of L2 in local EMI secondary schools. Johnson (1997) points to the stress of Hong Kong's late immersion model and questions the effectiveness of such a model in the present sociolinguistic environment, especially when very little attention is paid to distinguishing between the "conversational" and the "academic" aspects of language proficiency as mentioned before (Cummins, 1989). Third, the "pedagogy" for switching from Chinese to English at Form 1 (Grade 7) is largely not effective especially for those students who are marginally acceptable to be instructed in English.

At the school level, we recommend a language across the curriculum approach with close collaboration between language teachers and subject teachers to integrate the content and language curriculum to aid development in academic language proficiency (Man, Coniam, & Lee, 2002/2003). Currently opportunities for teachers in EMI schools to be trained in teaching in an English medium are limited, though some programs do exist (Man et al., 2002/2003). Training should be provided for teachers so that they can be more informed of such practices. Some schools in Hong Kong have practiced using materials in content subjects in English language lessons, and subject teachers have been trained to be more aware of their language role in teaching. Moreover, certain topics taught in English lessons have been scheduled to coordinate with some of the vocabulary and language structures taught in certain content subjects. A closer examination of classroom processes and how teaching and learning take place in EMI and CMI classrooms would be helpful. Issues such as code-mixing or code-switching and what can be done to best help students learn effectively can be re-visited. Successful practices should be documented and analyzed systematically. Good practices should be shared by other schools and teachers.

Various results in this study consistently point out that students from CMI-Low schools are disadvantaged not only in cognitive outcomes but also in non-cognitive outcomes. There is much room for improvement in the learning environment and learning processes in CMI-Low classrooms. More resources and support should be given to these less advantaged students.

For Researchers

Systematic research should be conducted to explore how to monitor and boost English language competence of students in CMI and EMI Schools. Given that the language environment of Hong Kong is predominantly Chinese, we cannot expect all students in EMI schools to be equally effective balanced bilinguals. A realistic goal is to reduce the achievement gap between L1 and L2. Allocating students to schools adopting a different instructional language according to their English proficiency is just the beginning and not the end. Students allocated to EMI schools are supposed to be able to learn effectively and to the best of their ability through English. Yet, this capability seems inadequate at the moment and needs to be further developed. The findings indicate that most of the Form 3 and Form 4 students perform much worse when being assessed in English, a language which they have been using for at least three years as a medium for learning. It suggests that they might not be learning effectively in their early years of EMI education or this kind of late immersion might not work very well when compared to other immersion experiences.

For Policy Makers

We recommend that policy makers should alleviate the unintended outcomes of the MOI policy. An unintended consequence of the present MOI policy is the possible increase of social segregation due to the academic segregation of this language policy. Results from HLM analysis indicated that students' academic segregation had been very stable previously but very high from 1996 to 2000. Although students are allocated to different types of MOI schools based on their language ability levels, academically segregated systems at the basic education level may induce a negative impact on social integration and mobility of students from different backgrounds. It is likely that children coming from the lower social class tend to be allocated to CMI schools. The results in the present study indicated that those students in CMI schools tend to have a lower self-concept and are less interested in learning. This social segregation early in the secondary school level might reinforce the disadvantageous condition of these students by accumulating teenagers with lower self-esteem and motivation in the same school.

The segregation of secondary schools by MOI is obviously detrimental in terms of labeling and streaming students in universal basic education. For educational, political, cultural, and economic reasons, Hong Kong needs to nurture students with bilingual competence. Therefore, any segregation of EMI and CMI schools should be reduced and even abandoned.

We need all Hong Kong secondary schools to be bilingual schools. As Tsang et al. (2004) suggested, Hong Kong can have schools with different models of bilingualism producing balanced bilinguals, Chinese-dominant bilinguals, and English-dominant bilinguals. The degree of bilingualism should be determined according to the students' language ability and also teachers' professional judgment. Immersion programs for these different types of bilingual schools should be redesigned and reviewed systematically so that students can improve both their Chinese and English without being scared of learning different subject matter in different content areas.

Language Environment

The language environment of Hong Kong differs from that of other bilingual countries such as Canada and Singapore. In the case of Canada, the geographic location can determine the language spoken. People are motivated to learn French when they are, say, in Quebec. In Singapore, children are accustomed to speaking in English and some speak their mother tongue out of school, while English is the common language for different ethnic groups to communicate. It is the multicultural and social context that affects which language is to be used. Unlike Canada and Singapore, over 98% of Hong Kong people are Chinese. They read traditional Chinese and speak Cantonese. Only a very small number of elites use English to communicate in their particular field. To some extent, it is difficult to require all children whose mother tongue is Cantonese to speak English in school. While there is no research evidence to suggest that students cannot learn in an L2, it is necessary to identify the optimal conditions in which additive bilingualism can effectively occur. Without a good bilingual environment, the successful implementation of an effective language policy in Hong Kong secondary schools may be constrained.

Notes

1. Education Department used the attainment test results to provide the information on ability grouping.
2. As there is only one EMI school with low student intake, results from that school were finally deleted in the final analysis.

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