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# FAMILY INFLUENCES ON SCIENCE LEARNING AMONG HONG KONG ADOLESCENTS: WHAT WE LEARNED FROM PISA

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ABSTRACT. This study investigated the relationship between family factors and students' scientific literacy performance in Hong Kong, which has excelled in science performance in previous international studies. Data were obtained from the 2006 Programme for International Student Assessment. Multilevel analysis was used to examine the relationship between parental involvement and investment and students' scientific literacy performance. It was found that students' scientific literacy performance, which was measured by their science achievement and self-efficacy towards science, were significantly associated with certain types of parental investment and involvement even after controlling background factors of both students and schools. Parental investment in cultural resources and parental involvement in terms of organising science learning enrichment activities at an early age were found to be significantly associated with students' scientific literacy performance. Activities that could be provided at an early age (e.g. watching TV programmes about science, reading books on scientific discovery, watching, reading or listening to science fictions) were found to be highly effective activities for promoting children's science achievement and self-efficacy.

KEY WORDS: early versus later involvement, family influence, Hong Kong, parental investment, parental involvement, PISA, science performance

Science and technology have a significant impact on everyday life. Over the past decades, East Asian societies—including Hong Kong—have consistently performed well in science on a number of international assessments such as Trends in Mathematics and Science Study and Programme for International Student Assessment (PISA; Organisation for Economic Co-operation and Development [OECD], 2001, 2005, 2007; Stevenson & Stigler, 1994). Researchers have primarily attributed this Asian achievement to factors related to classroom and teaching practices, intended and implemented curriculum and the centralised nature of the examination system (Stevenson & Stigler, 1994; Wong, 2008, 2009). This study takes a broader perspective by linking student performance to family processes and school social context, which exert a powerful influence on young people in Hong Kong.

Much of the literature on socialisation of children assumes that the advantages and disadvantages originating from the family occur during

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early childhood (Alwin & Thornton, 1984; George & Kaplan, 1997). Researchers have argued that experiences at an early age are significantly linked to the development of cognitive and affective learning outcomes later in life, that children's development requires adequate stimulation early in life and that later development may be dependent upon previous acquisition of basic skills and nurtured motivations. Yet, little has been done to examine the relative contribution of early versus later influence of family involvement on the educational experiences of young people. Moreover, there is an apparent scarcity of research dealing with the relative role of family arrangement of science activities at an early age in adolescents' later development of scientific literacy.

The purpose of the present study was to examine family influence on adolescents' science learning in Hong Kong. Since adolescents' capabilities and needs change during the school years, the present study takes into account parental involvement during earlier stages of childhood to understand the mechanisms of family influence in early versus later stages of child development as well as how different types of parental investment and involvement influence adolescents' development of science literacy.

## Background

The influence of family on children's education has been a major topic of the sociology of education for decades. In particular, previous studies have suggested that family commitment in resources and time has various impacts on children's schooling outcomes (Epstein et al., 1997; Ho & Willms, 1996; Shen, Pang, Tsoi, Yip & Yung, 1994). Cumulating evidence has also shown that promoting family involvement and mobilising family resources will have a significant positive impact on the student, namely enhancing achievement and self-esteem, improving behavioural and learning habits and lowering absenteeism and dropout rate (e.g. Bourdieu, 1986; Coleman, 1988, 1994; Ho & Willms, 1996). Yet, evidence from recent research challenges the position that more parental involvement may not always be beneficial, especially to adolescents (Pomerantz, Moorman & Litwack, 2007; Ho, 2002, 2003a, b).

Moreover, this body of research has not examined either the relative contribution of involvement versus investment or the early versus late family influence on the educational experiences of children. Much of the literature on socialisation of children assumes that the advantages and disadvantages originating from the family occur during early childhood in the form of cognitive and linguistic patterns associated with social inequalities. There are a number of theoretical reasons why one would

expect early experiences to be significantly linked to the development of cognitive abilities in later life. International research has examined how a child's reading habits and attitudes, which are nurtured at an early age, affect reading literacy later in life (OECD, 2002). One possible explanation is that cognitive and intellectual development may require sufficient stimulation early in life in order to take effect and later, development may be dependent upon the previous acquisition of other response systems. Yet, studies examining the relative role of family arrangement of science activities at children's early age in adolescents' science learning are apparently lacking.

For decades, parents in Hong Kong have been encouraged to be partners of the schools by donating their time to take part in school-related activities, and they have also been convinced to provide cultural, social, educational and material resources for children's learning (Shen et al., 1994; Ho, 2000, 2003a, b). However, the findings of local studies are mixed; it was found that *more is not always better*. While the impact on children's learning is dependent on the type of family investment and involvement, the significance of different types of involvement (e.g. homework supervision) also vary with the stage of schooling (Ho, 2003a, b).

This study examined to what extent different types of family investment and involvement are associated with students' scientific literacy performance. Specifically, the study addresses the following questions in the context of Hong Kong: What are the characteristics of family investment and involvement prevailing in secondary schools? What are the impacts of different types of family investment and involvement on students' scientific literacy performance with socioeconomic background and school context taken into account? What are the relative contributions of early versus late parental involvement on adolescents' scientific literacy performance?

## Conceptualisation and Operationalisation of Parental Investment and Involvement

### *Parental Investment*

Previous studies defined parental investment as the economic and cultural resources provided by parents for their children's education (Ho, 2003a, b). The PISA 2006 study identified and measured three types of resources: cultural, educational and material. These family resources

were measured in the student questionnaire used in PISA 2006 conducted in Hong Kong (HKPISA 2006).

*Cultural Resources.* Three items measuring cultural resources were constructed in PISA 2000 and were retained for PISA 2003 and 2006. The index of possessions related to classical culture in the family was derived from the students' reports on the availability of the following items at home: texts of classical literature, books of poetry and works of art.

*Educational Resources.* Five items measuring the availability of educational resources at home were constructed in PISA 2000 but slightly modified for PISA 2003 and 2006. The index of home educational resources was derived from the students' reports on the availability and number of the following items at home: a dictionary, a quiet place to study, a desk for study, textbooks and calculators.

*Material Resources.* Seven items measuring the availability of material resources were constructed in PISA 2000 but slightly modified for PISA 2003 and 2006. This index was derived from the students' reports on the availability of the following items at home: a room of your own, a link to the Internet, a dishwasher, a DVD or VCR player, a digital camera or video recorder, musical instrument (e.g. piano, violin) and pay TV channel.

The responses to these sets of questions within these three variables are binary. The scale construction was done through item response theory scaling with positive weighted likelihood estimate scores indicating higher levels of cultural resources, educational resources and material resources at home. The internal consistency of the cultural resources index was 0.55, the educational resources index was 0.37 and the material resources index was 0.44, which were quite low. Since these indices were generated by the consortium of OECD/PISA, the present study decided to keep it since the mean indices provide information about the extent of the three forms of parental investment relative to the OECD average.

*Parental Involvement*

In HKPISA 2006, there were 13 items of parental involvement in the parent questionnaire that were measured only in Hong Kong. Four constructs identified by factor analysis were regarded as a national—or, more appropriately, regional—option of Hong Kong. They are cultural

communication at home, educational and social communication at home, communication with school and participation in school.

*Cultural Communication.* The index of cultural communication was derived from the parents' reports on the frequency with which they engaged with their child in the following activities: discussing current affairs and social issues, discussing books, films or television programmes and listening to music. These items are borrowed from PISA 2000 with minor modification.

*Educational and Social Communication.* The index of educational and social communication was derived from the parents' reports on the frequency with which they engaged with their child in the following activities: discussing how well they are doing at school, spending time chatting and discussing homework. These items are borrowed from PISA 2000 with minor modification.

*Communication with School.* The index of communication with school was derived from the parents' reports on how often they had participated in the following activities during the preceding year: discussing with teachers about their child's learning, keeping contact with school and teachers and attending Parents' Day. These items are borrowed from Ho's (2002) home–school collaboration study.

*Participation in School.* The index of participation in school was derived from the parents' reports on how often they had participated in the following activities during the preceding year: keeping contact with other parents in their school, volunteering in school activities, participating in Parent Teacher Association and participating in programmes offered for parents. These items are borrowed from Ho's (2002) home–school collaboration study.

Parents responded to each of the two statements on home-based involvement on a five-point scale (1 = never or hardly ever, 2 = a few times a year, 3 = about once a month, 4 = several times a month, 5 = several times a week). The two statements concerning school-based involvement were measured with a similar five-point scale (1 = never, 2 = one to two times a year, 3 = a few times a year, 4 = once a month, 5 = several times a month). The internal consistency of the cultural communication index was 0.76, the education and social communication index was 0.74, the communication with school index was 0.68 and the participation in school index was 0.73, indicating satisfactory reliabilities among the items for each of these indices.

In addition, a new index of parental involvement was introduced in PISA 2006, which assessed arrangement of five different science activities by parents when their children were at age 10. This index was represented by six items in the parent questionnaire. A four-point scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree) was employed to solicit parents' responses. The internal consistency of this index was 0.76, indicating a satisfactory reliability of the measure.

## The Concept of Scientific Literacy Performance

PISA defined scientific literacy as "the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and make decisions about the natural world and the changes made to it through human activities" (OECD, 2000, p. 76). According to PISA 2006, to be literate in science, a student should demonstrate the cognitive ability as well as the affective capacity in examining scientific issues. This study used specific indicators of cognitive and affective performance from PISA 2006: the scale that represents the overall achievement of knowledge and skills of science and self-efficacy in science. The rationale for including these two constructs is that both the cognitive and the affective are regarded by educators as crucial factors in promoting life-long learning. Moreover, studies have found that self-efficacy can facilitate students' academic engagement and motivation (Skaalvik & Bong, 2003; Turner, Steward & Lapan, 2004).

Self-efficacy in PISA was assessed using a self-reported questionnaire. Students were asked to respond to eight items, each with a four-point rating scale (1 = strongly disagree, ... 4 = strongly agree). The items assessed students' self-confidence in solving specific tasks in science. Mean scores were calculated based on the scale. The higher the mean score, the better the affective performance. Table 4 presents the sample items. The value of Cronbach's alpha for self-efficacy was 0.83, indicating a high reliability among these items.

## Methodology and Analysis

The design of this study used the sampling of HKPISA 2006 and the additional information collected on Hong Kong to examine the effect of parental investment and involvement on the PISA 2006 scientific literacy performance. These data were analysed to identify relationships between

performances in two dimensions and indicators of parental investment and involvement.

### *Sampling in HKPISA 2006*

PISA 2006 in Hong Kong was conducted between May and June 2006. A two-stage stratified sampling design was used. In the first stage, schools were stratified based on school type (government, aided or independent) and achievement level of student intake (high, medium or low). Student intake refers to the incoming secondary 1 students of the academic year that the assessment takes place. The achievement level of each student is represented by the academic achievement index associated with the student, which is derived by combining the student's school performance and territory-wide assessment performance. This stratified sampling method ensures that schools of different backgrounds are appropriately represented in the sample. In the second stage, 35 students were randomly selected from each sampled school. A total of 4,645 students from 146 schools were accepted for final analysis according to the OECD sampling standard.

### *Analysis*

This study employed hierarchical linear modelling to examine the effect of parental investment and involvement on the two domains of scientific literacy performance—science achievement and self-efficacy in science (Bryk & Raudenbush, 1992). The analysis employs a multilevel design that is represented by three parts: (a) variation in student literacy performance in science achievement and self-efficacy among schools, (b) effects of student background including gender and parents' socioeconomic status (SES) measured by parent's occupation and education and school contextual factors such as the school average SES on the two aspects of students' scientific literacy performance and (c) effects of parental investment and involvement on the two domains of students' scientific literacy performance after controlling for student background and school contextual factors.

## Results and Discussions

This section summarises parental investment and involvement, science achievement and science efficacy and their relationships. The results are organised in alignment with the research questions.

*Parental Investment and Involvement in Hong Kong Education*

Table 1 shows descriptive statistics of parental investment. Since these three indices are constructed by OECD, we can compare parental investment in Hong Kong with those in OECD countries. The OECD index of parental investment is standardised with a mean of 0 and standard deviation of 1 for the combined student population of OECD countries. A negative value indicates that students responded less positively than the average response across OECD countries. Likewise, a positive value of the index indicates that students responded more favourably or more positively than the average response across OECD countries. The results indicate that average investments of Hong Kong parents in cultural resources (−0.30) and material resources (−0.39) are below the OECD average whereas investment in educational resources (−0.01) is only slightly below the OECD average. The underinvestment in cultural resources is the major weakness, which is consistent with the findings of the previous two cycles of HKPISA 2000 and 2003. Yet, the index of educational resources increased substantially from −0.19 in 2000 and −0.22 in 2003 to −0.01 in 2006.

Figure 1 shows the average level of parental involvement in science learning enrichment when their children were at age 10 across countries/regions that participated in the parent survey of PISA 2006. This OECD measure was constructed to assess to what extent parents arrange five forms of science activities when their children were at age 10. The Hong Kong index of early involvement is 0.13, which is slightly higher than the OECD average, indicating that Hong Kong parents do a little more in arranging science enrichment activities for their children than their OECD counterparts. However, the level of early involvement is higher than other East Asian societies, such as Korea and Macao.

Table 2 shows the other four forms of parental involvement, which are national options of Hong Kong only. Occurrence of the two forms of home-based involvement—cultural communication and educational and social communications—appears to be much greater than that of the two

TABLE 1

Descriptive statistics of parental investment in Hong Kong

| *Parental Investment* | *Minimum* | *Maximum* | *M* | *SD* |
|---|---|---|---|---|
| Cultural resources | −1.47 | 1.11 | −0.30 | 0.89 |
| Material resources | −4.82 | 3.78 | −0.39 | 0.92 |
| Educational resources | −4.35 | 0.82 | −0.01 | 0.84 |

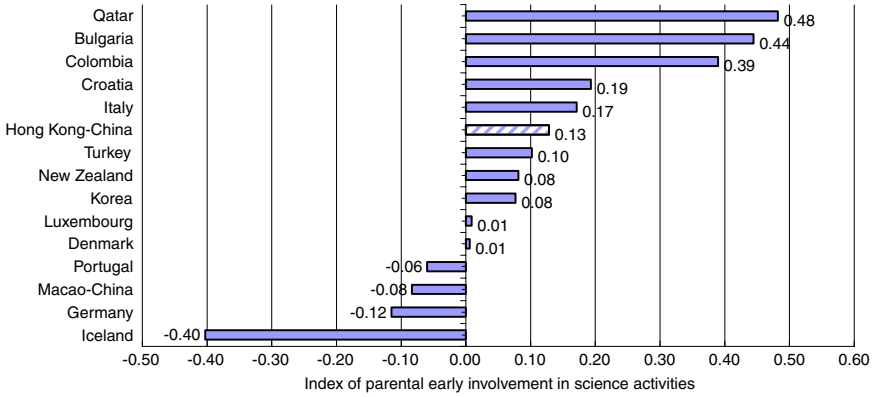


*Figure 1.* Parental involvement in science learning enrichment when children were at age 10 across selected countries/regions for PISA 2006

forms of school-based involvement. In other words, Hong Kong parents are used to communicating with their children at home but seldom participate in their children's school. Communication between home and school and parental volunteering in school activities are both rare. Under the traditional parenting culture, parents are not used to contacting schools and volunteering in schools, especially when their children are at secondary school level.

Overall, Hong Kong parents keep a distant relationship with schools. If parental involvement is a major avenue for Hong Kong educational reforms, further efforts must be made by the government and the schools to promote school-based involvement. Without the participation of active and enthusiastic parents, school volunteering and school governance involving parents would be problematic.

### *Scientific Literacy Performance of Hong Kong Students*

*Achievement in Science.* PISA 2006 performance of Hong Kong students in scientific literacy in a global context can be evaluated by comparing the

TABLE 2

Descriptive statistics of parental involvement in Hong Kong

| | *Minimum* | *Maximum* | *M* | *SD* |
|---|---|---|---|---|
| Cultural communication | 1.00 | 5.00 | 3.28 | 1.27 |
| Social and educational communication | 1.00 | 5.00 | 3.79 | 0.91 |
| Communication with school | 1.00 | 5.00 | 1.93 | 0.62 |
| Participation in school | 1.00 | 5.00 | 1.43 | 0.57 |

mean national scores of all participating countries/regions. Table 3 shows the top ten countries/regions with the highest performance in scientific literacy in PISA 2006 and indicates other regions' performance relative to that of Hong Kong. Hong Kong students ranked second among the 57 participating countries/regions ($M$=542, SE=2.5). The Hong Kong score is significantly lower than that of Finland ($M$=563) but significantly higher than all others. This result, together with similar results in PISA 2000 and 2003 studies, indicates that Hong Kong students consistently rank among the top three in scientific literacy.

*Self-Efficacy of Hong Kong Students.* Figure 2 shows self-efficacy towards science across participating countries/regions. Hong Kong's index of 0.07 is just slightly higher than the OECD average (zero). This result is in contrast to the earlier measure of a closely related construct, self-concept, where Hong Kong students generally had very low self-concept in reading (Ho, 2003b). A closer inspection of the content of the eight items that measure self-efficacy might reveal the reasons that lie behind the contrast between self-efficacy and self-concept in Hong Kong students.

The data in Table 4 indicate the percentages of 15-year-olds in Hong Kong and in other OECD participating countries that agreed or strongly agreed with the affective items. Five items (2, 3, 4, 5 and 7) have higher percentages of students agreeing than the OECD average. Item 2 for instance, about 80% of Hong Kong students believe that they can

TABLE 3

Mean performance in science achievement of the top ten participating countries/regions in PISA 2006

| *Country/region* | *Mean* | *SE* |
|---|---|---|
| Finland | 563 | 2.0 |
| Hong Kong, China | 542 | 2.5 |
| Canada | 534 | 2.0 |
| Chinese Taipei | 532 | 3.6 |
| Estonia | 531 | 2.5 |
| Japan | 531 | 3.4 |
| New Zealand | 530 | 2.7 |
| Australia | 527 | 2.3 |
| The Netherlands | 525 | 2.7 |
| Liechtenstein | 522 | 4.1 |
| Korea | 522 | 3.4 |

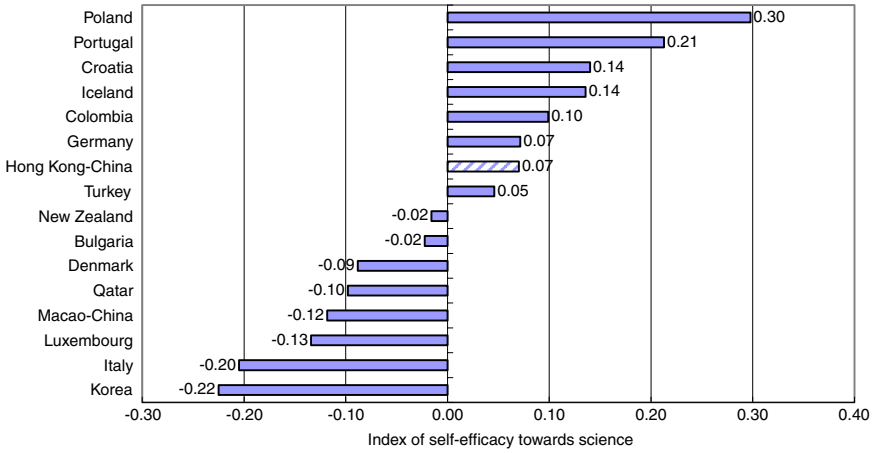


*Figure 2.* Self-efficacy in science across selected countries/regions for PISA 2006

recognise the science question that underlies a newspaper report on a health issue, which is slightly higher than the OECD average of 73%. Three items (1, 6 and 9) have lower percentages of Hong Kong students reporting confidence in handling the topics than the OECD average. The

TABLE 4

Percentages of Hong Kong students agreeing or strongly agreeing with self-efficacy items in science

| *Item* | *Hong Kong (%)* | *OECD (%)* |
|---|---|---|
| 1. Explain why earthquakes occur more frequently in some areas than in others | 70 | 76 |
| 2. Recognise the science question that underlies a newspaper report on a health issue | 80 | 73 |
| 3. Interpret the scientific information provided on the labelling of food items | 65 | 64 |
| 4. Predict how changes to an environment will affect the survival of certain species | 69 | 64 |
| 5. Identify the science question associated with the disposal of garbage | 72 | 62 |
| 6. Describe the role of antibiotics in the treatment of disease | 56 | 59 |
| 7. Identify the better of two explanations for the formation of acid rain | 75 | 58 |
| 8. Describe how new evidence can lead you to change your understanding about the possibility of life on Mars | 44 | 51 |

topic about earthquakes in item 1 is not a daily life concern in Hong Kong; the topic about life on Mars in item 8 and the topic in item 6 about antibiotics are not covered in the junior secondary science curriculum in Hong Kong. Junior secondary geography may consider earthquakes and life on Mars, but most schools do not adopt the geography curriculum in junior secondary. The S.4-5 Biology, Hong Kong has the topic *defence against disease*, which only covers the function to kill bacteria but does not cover the mechanism.

*Between-School Variance in Scientific Literacy Performance.* The total variance comprises two components: between-school variance and within-school variance. The percentages of the total variance that lie between schools in science achievement and self-efficacy in science for Hong Kong in PISA 2006 are 39.8% and 3.5%, respectively. The percentages of between-school variance indicate the heterogeneity of schools in a country. The ranges of between-school variance in science achievement among all participating countries/regions are wide—4% (Finland) to 57.8% (Czech Republic) in PISA 2000, 3.9% (Iceland) to 56.1% (Austria) in PISA 2003 and 5.8% (Finland) to 70.4% (Hungary) in PISA 2006.

In the case of Hong Kong, the between-school variance accounts for 39.8% of the differences in cognitive achievement in science, which is much higher than that of the measure for the affective domain, self-efficacy, which has a between-school variance of only 3.5%. Therefore, among schools in Hong Kong, the difference in science achievement between schools is substantial but not so in terms of efficacy in science.

However, compared with the HKPISA 2000 and 2003 studies, the proportion of between-school variance in science achievement has slightly reduced. This could be seen as a positive change associated with the comprehensive school reform in 2000, in which the student ability banding system was reduced from five streams to three streams.

### *Effect of Parental Investment and Involvement on Students' Scientific Literacy*

Tables 5 and 6 show the effects of student background, school social context and parental investment and involvement on students' science literacy scores and students' self-efficacy, respectively. Model 1 displays the effects of student background and school contextual factors. The percentage of students from a single-parent family, percentage of

TABLE 5

Effects of parental investment and involvement on students' science achievement in Hong Kong

| | *Model 1* | | *Model 2* | |
|---|---|---|---|---|
| *Predictor* | *Coefficient* | *SE* | *Coefficient* | *SE* |
| Intercept | 547.621 | 3.855 | 547.835 | 3.701 |
| Student background | | | | |
| Girl | −20.611*** | 2.647 | −20.193*** | 2.709 |
| SES | 5.277** | 1.329 | 4.013** | 1.519 |
| School background | | | | |
| School mean SES | 56.506*** | 7.896 | 52.892*** | 7.122 |
| Parental investment | | | | |
| Cultural resources | | | 3.142* | 1.551 |
| Educational resources | | | 1.222 | 1.750 |
| Material resources | | | 0.923 | 2.107 |
| Parental involvement | | | | |
| Science activities at age 10 | | | 9.068*** | 1.394 |
| Educational and social communication | | | 1.325 | 1.236 |
| Cultural communication | | | −1.444 | 1.322 |
| Communication with school | | | −6.569*** | 1.347 |
| Participation in school | | | −2.964* | 1.350 |
| Between-school variance | | 1972 | | 1833 |
| Within-school variance | | 4840 | | 4738 |
| Between-school variance explained (%) | | 30.10 | | 35.02 |
| Within-school variance explained (%) | | 2.26 | | 4.32 |

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

immigrant students at school level and percentage of girls were included as contextual factors. Results indicated that they were not significant; therefore, they were excluded from the final model. Model 2 displays the effects of parental investment and involvement on students' science literacy after controlling for background factors at both student and school levels. The results indicate that certain types of parent investment and involvement impact on students' achievement and self-efficacy significantly.

Results from model 1 in Tables 5 and 6 indicate that the background factors have significant influence on achievement and self-efficacy in science, respectively. The results indicate that girls tend to perform poorer than boys in science achievement; girls also tend to have lower levels of self-efficacy in science when compared

TABLE 6

Relationships of parental investment and involvement to students' self-efficacy in science in Hong Kong

| | *Model 1* | | *Model 2* | |
|---|---|---|---|---|
| *Predictor* | *Coefficient* | *SE* | *Coefficient* | *SE* |
| Intercept | 2.835 | 0.010 | 2.838 | 0.009 |
| Student background | | | | |
| Girl | −0.124*** | 0.018 | −0.127*** | 0.019 |
| SES | 0.057*** | 0.011 | 0.011 | 0.012 |
| School background | | | | |
| School mean SES | 0.116*** | 0.020 | 0.072** | 0.019 |
| Parental investment | | | | |
| Cultural resources | | | 0.058*** | 0.013 |
| Educational resources | | | 0.033** | 0.012 |
| Material resources | | | 0.033* | 0.015 |
| Parental involvement | | | | |
| Science activities at age 10 | | | 0.100*** | 0.009 |
| Educational and social communication | | | −0.007 | 0.011 |
| Cultural communication | | | 0.007 | 0.010 |
| Communication with school | | | 0.002 | 0.011 |
| Participation in school | | | 0.007 | 0.008 |
| Between-school variance | | 0.003 | | 0.001 |
| Within-school variance | | 0.266 | | 0.248 |
| Between-school variance explained (%) | | 73.01 | | 86.40 |
| Within-school variance explained (%) | | 2.21 | | 8.76 |

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

with boys. Students from higher SES family and those who studied in schools with higher average level of SES tend to achieve significantly better and exhibit higher self-efficacy than those from lower SES families as well as those who studied in schools with lower mean SES.

Results in model 2 suggest that the associations between certain types of parental investment and students' science literacy performance are significant. In general, students scored significantly higher in scientific literacy when they have more cultural resources, and they scored significantly higher in self-efficacy in science when they have more social and material resources at home.

Various types of parental involvement show different impact on students' literacy performance. Early parental involvement in arranging science activities when their children were at age 10 shows the strongest positive association with scientific achievement. Students whose parents arranged enrichment activities when they were at age 10 were more likely to have positive self-efficacy towards science.

The two forms of home-based involvement do not have any significant association with achievement in science and with students' self-efficacy in science. Cultural communication even shows negative association with students' self-efficacy in science. For the two types of school-based involvement, the regression coefficients of communication with school and participation in school are significantly negative in science achievement but not significant in self-efficacy towards science. The findings indicate that, when students reported that their parents had more contact with the school, they scored lower in science achievement but no significant effect was found on their self-efficacy.

These findings are quite consistent with the findings of HKPISA 2003. In fact, school-based involvement is still rare and problem-orientated in Hong Kong. Therefore, a possible explanation is that, although educational reform attempts to promote parental involvement not only at home but also at school through the school-based management policy, most parents and teachers still keep the traditional, separated relationship between home and school. It is likely that parents of low achievers are currently more likely to approach the school and participate at the school level to understand their children's problems. Further research is needed to clarify the nature of home–school interaction and parental participation and then longitudinal research to explore if school-based involvement can improve low achievers' learning over time.

Overall, the eight parental factors and three student and school background factors explain a total of 35% of the between-school variance and 4% of the within-school variance in science achievement, as well as a total of 86% of between-school variance and 8% of within-school variation in self-efficacy towards science. The calculation builds on the null model, which partitions the total variance of science achievement and self-efficacy towards science into between-school variance; then the between-school variance explained in the final model 2 can be calculated.

Further analysis of the HKPISA 2006 data related to arranging science activities by parents indicates that watching science TV programmes and

providing science books and science fictions are more effective than providing science websites and attending science clubs in enhancing science scores and self-efficacy at a later age (see Figures 3 and 4).

## Conclusions and Implications

This study examined family influence on students' science literacy performance at the secondary school level in Hong Kong. Special attention was paid to the nature and impact of parent investment and involvement. The results indicated that Hong Kong students performed well in science achievement, ranking second among the 57 participating countries/regions in PISA 2006. However, their self-efficacy toward science was only slightly above the OECD average. They reported a lower level of efficacy in handling topics such as earthquake and life on Mars, which are not directly covered in the current science curriculum in Hong Kong.

Regarding the nature and impact of parental investment and involvement in Hong Kong, this study identified three forms of investment and five types of involvement. Parents appear to be underinvested in cultural resources, yet this is the most important form of parental investment for enhancing children's cognitive and affective outcomes in science. Parents' arrangement of the five types of science activities when their children were at age 10 is slightly more frequent than the OECD average.

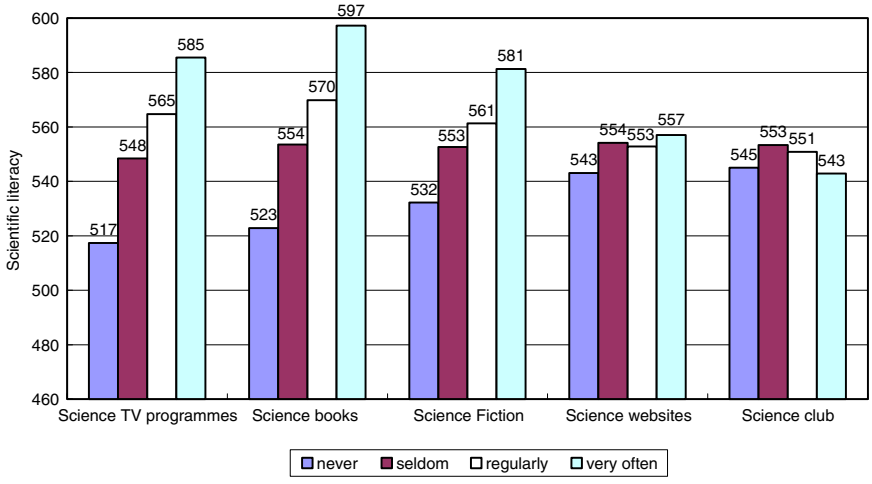


*Figure 3.* Variation in science achievement performance for different kinds of science activities arranged at 10 years old in Hong Kong

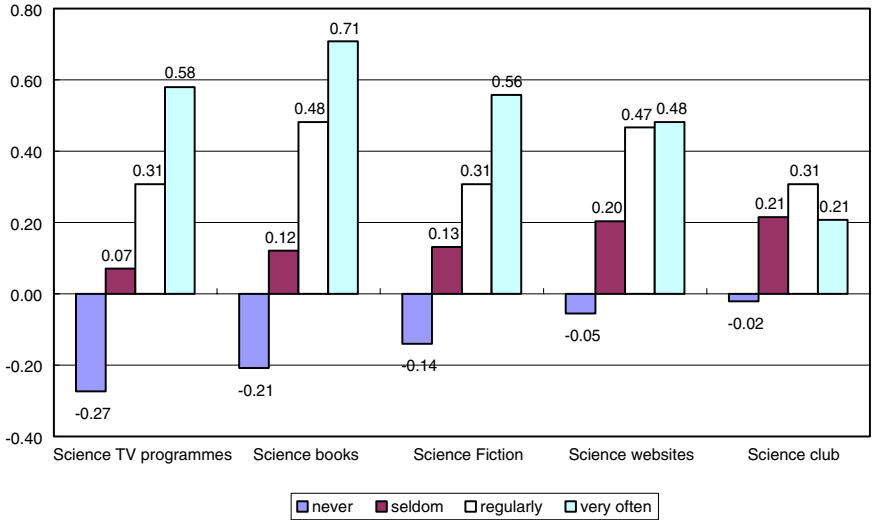


*Figure 4.* Variation in self-efficacy towards science for different kinds of science activities arranged at 10 years old in Hong Kong

The two forms of home-based involvement appeared to be more commonly practised among parents than school-based forms, namely communication with school and participation in school. School-based involvement is still rare in Hong Kong secondary schools. In investigating the effect of these five forms of parental involvement on students' science literacy performance, involvement at early stage appeared to be more important than the other four forms of involvement. These findings are consistent with those of Alwin & Thornton (1984) and George & Kaplan (1997) in the USA.

These results provide some insights for the formulation of policies regarding home–school cooperation, improvement of the school system and curriculum reform for science education. Regarding home–school cooperation, schools should expend more effort in informing parents about how to make better investment of their limited resources in cultural resources rather than material resources at home. Moreover, parent education should be funded on a long-term basis, with special emphasis on the quality of family activities at a child's early years. As for school improvement, most teachers welcome home-based parental involvement, but they feel uncomfortable with parental involvement in school activities and governance; and parents reserve their involvement to reacting to rather than proactive efforts. Although parents and teachers are not generally at odds with each other, the school is still regarded as teachers' territory and the home as parents' territory (Lam, Ho & Wong, 2002). Moreover,

the nature of home–school interaction and parental participation appears to be problem-oriented at the secondary school level. It is hoped that policy, practice and research projects may help construct positive interactions between the home and the school. The outcomes of such efforts will benefit especially low-achieving teenagers from disadvantaged families.

This study revealed that there are certain science topics that Hong Kong students feel less competent to handle. However, some of them such as earthquakes and the use of antibiotics could be an important issue at a local, national or global context. Curriculum developers in Hong Kong, especially those of science, may need to review the depth and breadth of the school curriculum with reference to the findings. This study confirmed the value of learning experiences outside schools, which should encourage parents and teachers to explore and make full use of the media and other channels for children's learning. However, out-of-school opportunities would have financial and other resource implications; hence, students from disadvantaged families need support from the government in order to engage these learning opportunities at an early stage of schooling.

Finally, the present analysis has offered only a limited basis for drawing inferences about the impact of parental investment in science learning. This is because the reliabilities of the three measures of family resources were generally low for Hong Kong. The major weakness is that these items, which are constructed internationally, have very low internal consistency locally and are not specific for nurturing interest in science. It seems that these items do not fit Hong Kong's situation and that more culturally sensitive and subject-specific items need to be developed for future studies.

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