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The Making of an Effective Sixth Form Education in Hong Kong: Evidence of School Provision and Decision Making from the Second International Science Study

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Based on the science achievement survey data collected in the IEA Second International Science Study, the present study seeks to provide empirical evidence to substantiate the Education Commission's reform proposals on: (1) the unification of the Sixth Form educational structure and the accompanying science curricular provision, (2) the upgrading of the educational standard of the private schools, and (3) the delegation of decision making related to the teaching of science to the teachers. When student intake into the various types of schools and their opportunity to learn the course content are controlled, this study establishes that the HKHL and HKAL matriculation curricula are equally effective as far as science achievement is concerned.

筆者之所以進行這個研究，是由於筆者認為，在 IEA 第二次對國際科學教育的研究中，有些關於科學學習成績的調查數據，是可以支持香港教育統籌委員會下列的改革建議：(1)應該統一大學預科學制及其相關課程；(2)提高私立學校的教學水準；(3)通過改革後的學校管理措施，下放更多權力給科學教師，使其能更好地決定自己的教學工作。筆者同時認為，只要有以下前提：(1)學生入讀不同類型的學校時，其入學水平是受到控制的；(2)他們學習課程內容的機會，是受到控制的而又用科學學習的成績為依據來衡量課程效能，則香港高等預科課程及香港高級預科課程的效能是不相伯仲的。

The Education Commission Report Number 2 (ECR2) proposed to unify Sixth Form education in Hong Kong with a common matriculation examination for entry into a 3-year university programme. ECR3 further proposed to standardise the structure of tertiary education and to raise the educational standard of private schools. The recently published ECR5 endorsed the School Management Initiatives which seek to define clearly management roles and give more flexibility in school management and administration. These proposals provide opportunities for an effective Sixth Form education in Hong Kong.

A lot of evidence is required to substantiate these Education Commission proposals. The primary purpose of this paper is to evaluate these proposals in the light of *some* of the evidence of school provision and decision making from the Second International Science Study (SISS) — part of this study is a sample survey of science achievement as well as an examination of the school/classroom science learning processes at the Sixth Form level in Hong Kong (see Cheung, 1989 for the product and process modelling results). Science achievement was chosen as the criterion of school effectiveness because of its visibility at this stage of schooling. This study highlights the under-achievement of the private schools which can be attributed to the less than adequate school and science teaching provision. In addition, this study seeks to establish the importance of teacher decision making on matters related to the teaching of science.

Two points which have a bearing on the design of this study are mentioned here. First, there were two different science curricula for the HKHL and HKAL matriculation examinations before the unification of the Sixth Form educational structure. The science achievement criterion, the basis for school effectiveness comparison for the two science curricula in this study, was adjusted for the effect of opportunity to learn after one year of Sixth Form study (i.e. Form 6 – grade 12). Second, the effect of the type of school on science achievement would take into account the kind of science curriculum that the school offered.

A Brief Review of the ECR Proposals

Before the conduct of enquiry of this study is described, a brief review of the ECR proposals is presented below. Since the 1986-ECR2 recommended an expansion of Sixth Form places and standardisation and diversification of the Sixth Form curriculum, a number of policy changes had taken place to tie in with this qualitative and quantitative expansion. Amongst these changes were the standardisation of tertiary education and the upgrading of the educational standard of the private schools. The consequence of the 1988-ECR3 was that the length of first degree courses should in principle be the same for any given subject at all tertiary institutions and that entry to a first degree course should be after S7 (grade 13) through the enforcement of some joint admission procedures of all UPGC-funded institutions. These proposals were hoped to be fully achieved in the 1994-97 triennium. All these policies intended to end the confusion regarding the role of the Sixth Form education in Hong Kong and the debate regarding the different educational standards of the HKHL and HKAL curricula.

It is informative to mention that the replacement of the Bought Place Scheme by the Direct Subsidy Scheme has provided a golden opportunity for the private schools to upgrade their educational standards and improve their school provision and resource support. During the 80's, a greater proportion of the private schools offered the HKHL curriculum than the government, grant and subsidised schools. Because of the belief that the private schools were inferior in educational status, it has cast an impression that the HKHL curriculum was of lower educational standard than the HKAL curriculum. This study attempts to throw lights on this controversial issue.

The recent 1992-ECR5 endorsed the implementation of the School Management Initiatives — a scheme to delineate clearly the roles of the various stakeholders in the schooling process in order to bring about a more efficient and effective school management and administration framework. It was hoped that this scheme, if successfully implemented, would respect more the many roles of the teachers and would value more teaching as a profession than before (see Wong, 1991 & Cheng, 1992 for some initial responses to the management reforms). In this regard, this paper intends to give some evidence to support the implementation of the proposed management and administrative framework when greater participation for teachers to engage in decision making on matters related to teaching and learning can be shown to be beneficial.

The Sample Survey Design

The data for this study were derived from the IEA Hong Kong Science Study, which was conducted in 1984-85 (see Holbrook, 1990, for the national report). All secondary schools offering science as part of their Sixth Form (grade 12) curriculum were classified into four major exclusive strata of type of school (government, grant, subsidised, and private) and the numbers of these schools were obtained to define a target population of 272 schools. A probability sample of 163 schools was randomly drawn within strata at the first stage of sampling, followed by all science students selected from the sampled schools at the second stage. Data were obtained on 6103 students in 217 classes from 158 schools. This design permitted analyses at the between-school or between-class levels, where there was a response rate of 96.9%. The achieved sampling fractions of students and schools were 50.4% and 58.1% respectively. Because of the non-response and the clustered, stratified nature of the sample, the school, teacher and student data were weighted according to the type of variable used and the level of analysis conducted (for details on the calculation of weights, see Cheung, 1989, pp. 75-80). It is noteworthy that this sample is of historical significance — it was the first cohort of secondary students reaching the Sixth Form matriculation level since the government introduced universal compulsory education for all students under the age of 15 (i.e. reaching Form 3 — grade 9). Details of the sampling and administration procedures are documented in Holbrook (1990, pp. 10-14).

The School Effectiveness Criterion: The Adjusted Science Achievement Measures

Critical to this study is a careful conceptualisation of the school effectiveness criterion. In fact, the implementation of the science curriculum was by no means homogeneous across the schools; particularly when there were two different science streams (physical/biological) as well as two different science curricula (one-year HKHL/two-year HKAL) at the matriculation level in Hong Kong. Consequently, student achievement could be severely affected by the quantity of schooling and their opportunity to learn the subject matter before they were tested. In the SISS, there were teachers' Opportunity-to-Learn (OTL) ratings of the test items, allowing an estimation of the curriculum implementation effects. Thus, the science achievement measures, the school effectiveness criterion in this study, would be adjusted statistically by partialling out the implementation effects due to the different science streams and curricula *after one-year of Sixth Form study.* In sum, the physics, chemistry and biology achievement measures were raw total scores of the test items from a core and specialised paper-and-pencil tests, and their adjusted measures were the residualised measures resulting from regression analyses on the OTL ratings (for details of the test items and OTL ratings, see Holbrook, 1990, pp. 15-39; for details of the regression analyses, see Cheung, 1989, pp. 108-113). IEA has paid particular attention to cross-national comparability and curriculum relevance by employing a combination of national and international items. The reliabilities of the physics, chemistry and biology achievement measures are also found to be satisfactory (KR-20 reliabilities, measures of internal consistency, are 0.74, 0.79 and 0.69 respectively).

Decision Making Responsibilities and Effectiveness

In the general running of the school, and science teaching in particular, different personnel will be involved in making decisions on school administration and matters related to the proper conduct of science teaching. In the SISS, the school questionnaire contained a list of eleven tasks for the school principal to check whether it was the central authority/school council, the principal, or the teachers (decision levels 3, 2 and 1 respectively) who were responsible for making these decisions. Admittedly, there may be other more important tasks not included in the list. The eleven tasks, together with the ordinal variable names enclosed in brackets indicating the designated levels of decision making, are summarised below:

1. Determining the range or type of science subjects taught in the school (RANGE);
2. Determining the content of the science courses at individual grade levels (CONTENT);
3. Choosing textbooks for science students (TEXT);
4. Selecting science equipment (EQPT);
5. Selecting students for entrance to the school (ENTRANCE);
6. Determining the size of the tuition fees (FEE);
7. Deciding on major expenditure (e.g. new buildings) (EXPEND);
8. Determining the conditions for employment for teachers (CONDITION);
9. Selecting teachers for the schools (SELTCHR);
10. Selecting the school principal (SELPRIN);
11. Making rules and regulations for the students (RULE).

Not surprisingly, the principal's ratings showed that it was the central authority or school council who was responsible for the determination of the size of tuition fees, deciding on major expenditure, determining conditions of employment for teachers, and the selection of the teachers. They, together with the school principal, would also be involved in selecting teachers for the schools. The main responsibilities of the principals were to determine the range and types of the science subjects taught in the schools, and to make rules and regulations for the students. Decisions on student entrance mainly lay with the principals, in consultation with the teachers and the school council. At this senior secondary level, the science teachers had a great degree of autonomy in determining the content of science courses at individual grade levels, choosing science textbooks for the students and purchasing appropriate science equipment. Finally, it can be further summarised that school administration decisions pertaining to the whole school (i.e. FEE, EXPEND, CONDITION, SELTCHR, SELPRIN and RULE) had higher item means and smaller standard deviations, whereas those decisions pertaining to the teaching of science (i.e. RANGE, CONTENT, TEXT and EQPT) had smaller item means and larger standard deviations. This demonstrates that, even at the senior secondary level, the teachers' power of decision making was seldom absolute and might need to be approved by their superiors.

As far as school effectiveness is concerned, the first observation is that relationships between the locus of authority for school administration and science teaching decisions (i.e. the three ordinal decision levels) with the adjusted science achievement measures were only weak (physics: $0.071 < \text{Eta} < 0.160$; chemistry: $0.072 < \text{Eta} < 0.177$; biology: $0.024 < \text{Eta} < 0.169$; Eta-squared is the variance ratio of between sum of squares to the total sum of squares). In order to arrive at a smaller number of decision constructs, factor analysis was conducted. Altogether, two common principal factors would be extracted from the two decision variables (except SELTCHR because of zero variance), accounting for a total of 30.3% of the total item variances. Judging from the factor pattern loadings and the structure coefficients, the two extracted common factors, which were orthogonal to each other (r = -0.093), were labeled as: (1) School Administration Decision (SCHADMIN) and (2) Science Teaching Decision (SCITEACH).

The Pearson Correlations of SCHADMIN and SCITEACH with the adjusted physics, chemistry and biology achievement measures (APHYSCRE, ACHESCRE and ABIOSCRE) revealed different patterns of relationships. When administrative decisions were made by the central authority/school council, these were found very weakly related to better physics and chemistry achievement (r = 0.119 and 0.118). (N.B. None of the three correlations between adjusted science achievement scores and SCHADMIN were significant at Alpha equals 0.05). On the other hand, the correlations between the adjusted science achievement measures with SCITEACH were relatively higher, indicating that more involvement for the science teachers in teaching-related decisions would enhance school science achievement (r = 0.160, 0.130 and 0.137). (N.B. These correlations were significant at Alpha equals 0.05 for physics and at Alpha equals 0.10 for chemistry and biology.)

Effects of Type of School and Science Curriculum on Science Achievement

In the past decades, there were two science curricula at the Sixth Form level in Hong Kong. These curricula were not of equal popularity because of the absence of an appropriate language of instruction policy, as well as because of the different admission policies of the two universities of Hong Kong. It was believed that students studying in schools offering the HKHL curriculum (18.5%), who were normally in the private Chinese Middle schools, were in a disadvantageous position compared with those in the HKAL curriculum (76.7%). Some schools (4.8%) operate both science curricula in their schools. Thus, in the achieved sample, there was a very disproportionate relationship between Type of School and Science Curriculum. The result is that Type of School and Science Curriculum were strongly associated (Contingency C = 0.516 and 0.316 when analysed at the school and classroom levels respectively). Hence students' levels of science attainment were not only a function of Type of School attended but also a function of the science curriculum pursued. The government and grant schools operated mainly the HKAL curriculum whereas the subsidised and private schools had a choice between the two, depending on the university for which they were preparing their students. 14.28% and 81.48% of the subsidised and private schools respectively offered entirely or in part the HKHL science curriculum in their schools.

Two-way analyses of variance (ANOVA) on science achievement were performed to examine whether there were any Type of School and Science Curriculum main effects. Since some schools operated both curricula at their Sixth Forms, these analyses had to be conducted at the between-class level to determine whether there were any significant effects (i.e. Main and Interaction Effects) on class physics, chemistry and biology achievement. Because of the different science curricula which necessarily result in differences in teaching progress, the adjusted science achievement scores (APHYSCRE, ACHESCRE and ABIOSCRE) were used as the criterion measures.

The ANOVA design was not a balanced design since the cell frequencies in Table 1 were not proportional to the marginal frequencies of the two classifying variables (i.e. Type of School and Science Curriculum). The consequence was that the two main effects were confounded and the interaction effects would not be independent of the main effects. The ANOVA analyses strategy used was such that the main effects were adjusted between each other, and the two-way interaction was adjusted for the two main effects simultaneously (N.B. This approach is termed as the classical experimental approach. See Nie, et al., 1975). In this way, when in the absence of any interaction effect, the main effects were actually independent effects.

The ANOVA results shown in Table 2 were consistent in revealing that there were no interaction effects, after adjusting for the two main effects, namely the Type of School and Science Curriculum. The Science Curriculum main effect, after taking into account the Type of School main effect, was not significant at Alpha equals 0.05. This finding contradicts the general belief that students' performances on the HKHL curriculum were inferior to those following the HKAL curriculum. The breakdown statistics shown in Table 1 illustrates clearly that the government and grant schools' attainment levels were the highest whereas the private schools were the lowest. The Type of School main effects, after adjusting for the Science Curriculum main effect, were all significant at Alpha equals 0.05.

TABLE 1
Breakdown Statistics of Adjusted Science Achievement on Science Curriculum and Type of School

	Science Achievement (Mean/SD/N)					
	APHYSCRE		ACHESCRE		ABIOSCRE	
Type of School	HL	AL	HL	AL	HL	AL
Government	62.48	52.71	54.33	51.95	60.09	54.55
	0.00	5.50	0.00	4.34	0.00	3.97
	1	19	1	19	1	13
Grant	–	52.94	–	54.23	–	50.82
		4.90		5.99		4.79
		16		16		11
Subsidized	48.36	50.59	51.46	50.71	51.76	50.93
	5.39	4.90	5.20	4.05	4.36	4.17
	15	104	16	104	15	88
Private	47.12	47.78	45.52	47.79	47.20	46.17
	5.16	4.57	6.55	4.24	5.59	4.15
	26	42	26	40	24	23

Note: APHYSCRE = Adjusted Physics Achievement Score
ACHESCRE = Adjusted Chemistry Achievement Score
ABIOSCRE = Adjusted Biology Achievement Score

The Construction of School Provision and Resource Constructs

The school questionnaire contained a number of questions on school provision and resource support for science teaching. Some of these variables are alterable and have bearings on both the quantity and quality of instruction. For the purpose of this study, the following school level variables were constructed to highlight the underachievement of private schools.

1. The effective number of science laboratories in use (LABQUAN) - i.e. LABQUAN = number of laboratories x % of laboratory use
2. The effective number of laboratory assistants (LABHELP) - i.e. LABHELP = number of assistants x % of laboratory use
3. Quantity of schooling in minutes at the Sixth Form level per 5-day week (QUANSCHW)
4. Allocated time in minutes on physics learning at the Sixth Form level per 5-day week (QUANPHYW)
5. Allocated time in minutes on chemistry learning at the Sixth Form level per 5-day week (QUANCHEW)
6. Allocated time in minutes on biology learning at the Sixth Form level per 5-day week (QUANBIOW)
7. The school pupil-teacher ratio (PTRATIO) - i.e. PTRATIO = total number of students in school/total number of full-time equivalent teaching staff

TABLE 2
ANOVA Results of the Effects of Type of School and Science Curriculum on Adjusted Science Achievement Measures

	Science Achievement								
	APHYSCRE			ACHESCRE			ABIOSCRE		
Source of Variation	*df*	*F*	*p*-value	*df*	*F*	*p*-value	*df*	*F*	*p*-value
Main Effects	4	8.107	0.000*	4	12.519	0.000*	4	12.561	0.000*
Type of School	3	8.003	0.000*	3	13.302	0.000*	3	15.997	0.000*
Science Curriculum	1	1.337	0.249	1	0.782	0.378	1	1.544	0.216
2-Way Interaction	2	2.652	0.073	2	1.763	0.174	2	0.484	0.617
Explained	6	6.289	0.000*	6	8.934	0.000*	6	8.536	0.000*
Residual	216			215			168		
Total	222			221			174		

*Significant at Alpha = 0.05
Note: APHYSCRE = Adjusted Physics Achievement Score
ACHESCRE = Adjusted Chemistry Achievement Score
ABIOSCRE = Adjusted Biology Achievement Score

8. Percentage of graduate science teachers (PGRADSCI) - i.e. PGRADSCI = total number of gradute science teacher/total number of full-time equivalent teaching staff
9. Total school annual expenditure per student (EXPENPUP) – i.e. EXPENPUP = total annual expenditure on academic staff and non-academic staff/total number of students

As anticipated, school provision and resource support differ according to the type of school because of the different financial support. Table 3 details the breakdown statistics to illustrate these distributions. The two school decision and administration constructs (i.e. SCHADMIN and SCITEACH) composed earlier were also included. Although most statistics are self-explanatory by definition, certain patterns of school provision and of administrative decisions are note-worthy and are summarised below:

Firstly, there were significant differences in school provision and administration amongst the various type of school (0.22 < Eta <0.67). The differences mainly stemmed from the publicly-funded versus private schools.

Secondly, the private schools were low in laboratory support, allocated instructional time, specialised science teaching staff, and high in pupil-teacher ratio. Actually, a substantial number of private schools were half-day schools running both morning and afternoon sessions in order to maximize student intake and use of school facilities.

Thirdly, the grant schools were generally well-financed by their parent body and the government, and were able to provide better laboratory support and specialised science teaching staff than the government and subsidised schools. Due to their reputation, they were big schools and had relatively higher pupil-teacher ratios than the government and subsidised schools. However, the allocated times for schooling overall and for science instruction were similar amongst the publicly-funded schools, as required by the Education Department.

Fourthly, breakdown on SCHADMIN and SCITEACH revealed that there were two main groups of school administration patterns: those of government and subsidised versus grant and private schools. In government and subsidised schools, the government or school council normally made decisions on school expenditures and had quite rigid administrative rules. However, the teachers were relatively free to propose recommendations relating to the teaching of science. Grant and private schools were normally governed by a school council and all the decisions in practice are the responsibility of the school supervisor or principal. The teachers generally did not have ample opportunities on decision making relating to the teaching of science.

Fifthly, in order to obtain a smaller number of empirically distinct dimensions related to school provision and administration patterns, the ten school provision and resource support variables (except QUANBIOW) were factor-analysed. QUANBIOW was not included because ten schools did not offer a biological stream. Altogether, three conceptually distinct common oblique factors were extracted, accounting for 52.5% of the total variations of the variables. Judging from the factor pattern loadings and the structure coefficients, the three common factors could be labeled as (1) Science Teaching provision (SCIPROV); (2) Laboratory Support (LABSUPT); (3) School Provision (SCHPROV). As anticipated, SCIPROV and SCHPROV were empirically found to be correlated together (r = 0.611), indicating that the science teaching provision and decisions were subsumed under the general school provision. LABSUPT was also found to be empirically distinct from SCIPROV and SCHPROV (r = 0.153 and 0.084 respectively).

Relationships of School Science Provision with Type of School and Science Curriculum

As noted in earlier sections, the two pre-university curricula posed different requirements on the schools in providing resources, laboratory support, instructional time and concomitant management arrangements. These provision were found to vary amongst the various types of schools. Hence two-way analysis of variance was performed on SCIPROV, LABSUPT and SCHPROV to assess if there were Type of School and Science Curriculum main effects. Analysing on the three dimensions instead of the individual variables would give a more coherent view with regard to these effects. In the case of schools offering both HKAL and HKHL curricula, the provision information was known to reflect those of the HKAL curriculum. Hence, this analysis was conducted at the school level with two levels on the science curriculum. The two-way factorial ANOVA followed the classical experimental approach to cope with the unbalanced design. Table 4 and 5 detail the ANOVA results. It is of interest to note that different patterns of main and interaction effects are observed on the three school provision dimensions. The findings are summarised below.

1. *SCIPROV and LABSUPT*. Since there were significant interactions (p = 0.000 and 0.001) on SCIPROV and LABSUPT between Type of School and Science Curriculum after adjusting for the two main effects, the independent significant Science Curriculum effect should be examined with caution since it might differ amongst the various types of schools.

TABLE 3
Breakdown of School Resource and Provision Variables on Type of School (N = 158)

Resource & Provision Variables	Government [16]	Grant [10]	Subsidized [105]	Private [27]	Total [158]
	School Mean (Standard Deviation)				
Science Laboratories					
LABQUAN	3.46	3.77	3.15	1.89	3.00
{0.47}	(1.12)	(1.43)	(0.89)	(1.26)	(1.15)
Laboratory Assistants					
LABHELP	2.10	2.46	2.02	1.59	1.98
{0.22}	(0.85)	(0.74)	(0.73)	(1.53)	(0.94)
Total Learning Time					
QUANSCHW	1550	1581	1605	1322	1549
{0.67}	(77)	(90)	(96)	(193)	(157)
Physics Learning Time					
QUANPHYW	333	339	332	216	313
{0.63}	(49)	(57)	(53)	(62)	(70)
Chemistry Learning Time					
QUANCHEW	339	334	335	214	314
{0.65}	(48)	(57)	(54)	(59)	(71)
Biology Learning Time					
QUANBIOW	376	378	358	230	338
{0.57}	(68)	(60)	(72)	(93)	(90)
Pupil-Teacher Ratio					
PTRATIO	22.51	30.25	23.91	36.92	26.44
{0.35}	(1.84)	(24.36)	(6.94)	(26.33)	(14.49)
%Graduate Science Teacher					
PGRADSCI	0.81	0.86	0.77	0.49	0.73
{0.58}	(0.13)	(0.14)	(0.14)	(0.25)	(0.20)
Expenditure Per Student					
EXPENPUP	4557	5586	4640	2388	4305
{0.66}	(2122)	(392)	(877)	(861)	(1376)
School Administration Decision					
SCHADMIN	4.13	-4.95	1.17	-6.26	-0.18
{0.37}	(2.83)	(12.01)	(7.21)	(12.60)	(8.97)
Science Teaching Decision					
SCITEACH	2.78	-2.74	1.28	-6.95	-0.21
{0.38}	(5.77)	(6.44)	(7.04)	(11.95)	(8.49)

Note:
1. Eta is in curly brackets
2. 148 schools offer biology stream in their Sixth Form
3. SCHADMIN is multiplied by 10
4. SCITEACH is multiplied by -10
5. Number of schools is in square brackets

TABLE 4
Breakdown Statistics of Laboratory Support, Science and School provision on Science Curriculum and Type of School

	Resource and Support Constructs (Mean/SD/N)					
	SCIPROV		LABSUPT		SCHPROV	
Type of School	HL	AL	HL	AL	HL	AL
Government	30.30	53.95	43.32	52.98	50.21	53.15
	0.00	3.58	0.00	9.35	0.00	5.71
	1	15	1	15	1	15
Grant	–	52.77	–	55.76	–	53.30
		7.94		10.89		3.97
		10		10		10
Subsidized	34.44	54.81	50.35	50.09	49.02	53.18
	2.80	4.63	8.85	7.37	6.02	3.08
	12	93	12	93	12	93
Private	32.56	38.89	38.22	54.94	34.04	33.11
	8.80	7.66	5.53	15.43	9.92	6.26
	15	11	15	11	15	11

Note: SCIPROV = Science Provision
LABSUPT = Laboratory Support
SCHPROV = School Provision

In the case of SCIPROV, those schools offering the HKAL curriculum were consistently having higher means (i.e. more science teaching provision) than those offering only the HKHL curriculum amongst the four types of schools, although the differences were less marked in the private schools. The Type of School effect was very evident amongst the AL schools whereas this effect was less certain amongst the HL schools. On the whole, it was valid to conclude that the private schools were relatively inadequate in providing science teaching resources and this was particularly serious for the HKAL curriculum.

The laboratory support for the HKAL curriculum was relatively homogeneous amongst the four types of schools. This was understandable because the schools had to reach certain minimum laboratory provision standards before their students were allowed to take the HKAL practical examinations offered by the Examination Authority. Only those private schools following the HKHL curriculum were deficient in laboratory support. These standards were tolerable amongst the students since in the HKHL examinations the written instead of the genuine practical skills were assessed. The publicly maintained schools generally could reach the standard as laid down by the ordinance irrespective of the curriculum offered.

TABLE 5
ANOVA Results of the Effects of Type of School and Science Curriculum on Laboratory Support, Science and School Provision

	Resources and Support Constructs								
	SCIPROV			LABSUPT			SCHPROV		
Source of Variation	*df*	*F*	*p*-value	*df*	*F*	*p*-value	*df*	*F*	*p*-value
Main Effects	4	89.8	0.000*	4	6.131	0.000*	4	82.73	0.000*
Type of School	3	18.1	0.000*	3	1.659	0.178	3	74.19	0.000*
Science Curriculum	1	139.9	0.000*	1	9.789	0.002*	1	3.70	0.056
2-Way Interaction	2	13.9	0.000*	2	7.844	0.001*	2	2.09	0.128
Explained	6	64.9	0.000*	6	6.702	0.000*	6	55.85	0.000*
Residual	150			150			150		
Total	156			156			156		

*Significant at Alpha = 0.05
Note 1: SCIPROV, LABSUPT and SCHPROV were scaled to have means and standard deviations equal to 50 and 10 respectively.
Note 2: SCIPROV = Science Provision
LABSUPT = Laboratory Support
SCHPROV = School Provision

2. *SCHPROV*. There were no interaction effect after adjusting for the two main effects, namely Type of School and Science Curriculum. The Science Curriculum main effect, after taking into account the Type of School main effect was not significant at Alpha equals 0.05. However, the independent Type of School effect was significant ($p = 0.000$) amongst the public and private schools. The private schools, in both the HKAL and HKHL curricula, were under-provided in instructional time and specialised science teaching staff, and they maintained high pupil-teacher ratios and low expenditures per pupil.

A Summary of Findings

The following evidence is found to support the ECR recommendations in the unification of Sixth Form educational structure, upgrading of educational standards of the private schools, and the delegation of decision making relating to classroom teaching to the teachers:

Firstly, the Pearson Correlations of the science achievement measures with the level of decision making on teaching-related matters (e.g. selecting science equipment, choosing textbooks for science students) indicate that teacher involvement would enhance to a small extent science achievement of the students.

Secondly, the ANOVA results show that the science curriculum main effects, after taking into account the type of school main effect, were not statistically significant. This contradicts the general belief that students' performance of the HKHL curriculum is inferior to that of those following the HKAL curriculum. This finding highlights the inequity issue regarding the content of science education students received, and at the same time, the concomitant differing student matriculation entry requirements and the school and science provision for implementing the HKHL and HKAL science curricula. Because of this inequity, the two matriculation systems should be unified.

Thirdly, after adjusting for the science curriculum main effect, the ANOVA results show that the government and grant schools' science attainment levels are the highest whereas the private schools are the lowest.

Fourthly, the breakdown statistics on a selected number of school provision, laboratory support and science provision variables show that the grant schools are able to provide better laboratory support and specialised science teaching staff than the government and subsidised schools. The private schools were found low in laboratory support, allocated instructional time, specialised science teaching staff, and high in student-teacher ratio. The breakdown statistics further shows that there are two main groups of school administration patterns — those of government and subsidised versus grant and private schools.

Fifthly, more detailed ANOVA analyses on the school provision and decision making variable constructs reveal that the type of school, and to a lesser extent, the science curriculum, determines the level of school provision.

Conclusion

This study sought to evaluate retrospectively some of the educational reform proposals for the Sixth Form educational structure and the associated science curricula by using a historical sample of Sixth Form students — they were the first cohort of students who have experienced all the policy changes since the introduction of compulsory education in 1978 — surveyed in the Second International Science Study. Conditioned by the availability of data, this paper concludes with a speculation that any school provision effects on science achievement can be perceived as mediating effects of the Type of School effects (see Cheung, 1992a for a validation of this speculation). At a time when equity is of societal concern, there is no reason not to have a unified science curriculum, whether it is of a one- or two-year duration, that is in accordance with contemporary aims of science education (see Cheung, 1990 for the changing aims of science education for an uncertain future; see also Cheung and Taylor, 1991 & Cheung 1993 for a humanistic constructivist perspective of science learning). Furthermore, it has been demonstrated that there is an intimate relationship between teaching approaches and the cognitive demand of a science curriculum (Cheung, 1992b) and that it is desirable to have practical work in the science curriculum. Therefore, the findings of this study substantiate in part the ECR proposals for upgrading the standards of private schools, unification of the Sixth Form educational structure and its curricular provision, and the delegation of decision making relating to classroom teaching to the teachers.

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