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# Enhancement of classroom facilities of primary schools and its impact on learning behaviors of students

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## Abstract

**Purpose** – The aim of this paper is to investigate the effectiveness of the enhanced school facilities and the impacts of this enhancement on the learning behaviors of students

**Design/methodology/approach** – A pre- and post-occupancy evaluation questionnaire was administered in 2003-2004 to 750 primary students who had studied in both the old schoolhouses and the new Millennium Schoolhouses.

**Findings** – The results revealed that all of the FM components except teaching tools were improved in the millennium schools, while most of the learning behaviour (LB) components showed no changes. However, an interesting finding was that most of the improved FM components correlated to the enhanced LB of the students in the millennium schools.

**Research limitations/implications** – There was only a three to four months period between the pre- and post-occupancy evaluation in the study. To ensure the effectiveness of upgraded FM in millennium primary schools and to understand the long-term impacts on the learning outcomes of students, a longitudinal post-occupancy evaluation study in these three millennium schools is recommended.

**Practical implications** – It is suggested that a longitudinal POE study be conducted in these three millennium schools in order to understand the long-term impact of facilities management in millennium primary schools, especially the impact on the academic performance of students.

**Originality/value** – Architects and facilities managers should further discuss with teachers about how to encourage students in classrooms to be self-disciplined, redesign the layout, and reconsider the teaching tools that today's primary students need.

**Keywords** Classrooms, Primary schools, Learning, Behaviour, Hong Kong,

**Paper type** Research paper

## Introduction

In recent years in Hong Kong, total education expenditure on schools has increased continuously grown from HK$48,000 million in 1998/1999 to HK$55,000 million in 2002/2003 (Education and Manpower Bureau, 2004), while Hong Kong was facing senior financial virus (2.49 per cent of GDP was decreased from $1,280 billion in 1998 to $1,248 billion in 2002) (Census & Statistics Department, 2005). Most of the additional educational budget was used to upgrade school facilities such as computers, projectors, and air-conditioning systems. However, whether the allotment of education funds is

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effective and whether the upgraded facilities can improve teaching effectiveness and learning behaviors in the education process are still controversial issues.

Most of the previous facilities management (FM) studies concentrated on the improvement of design and technology but neglected the actual needs of the end-users in buildings (Shohet and Lavy, 2004; Gopalakrishnan *et al.*, 2003; Ahmadi *et al.*, 2000). Post-occupancy evaluation (POE) focuses on the needs and satisfaction of occupants within a specific building (Preiser *et al.*, 1988). It provides an important channel through which construction professionals can come to understand the basic requirements of end-users in the building.

In primary schools, students, as well as teachers, are the typical end-users, while the purpose of facilities enhancement is to improve students' learning. This paper identifies the major components of facilities management in classrooms and the learning behaviors of students in primary schools in Hong Kong. Schoolhouses including school buildings and all related facilities constitute the students' learning environment. By comparing the quality of major components in old schoolhouses with the quality of those in new schoolhouses, the impacts of enhanced facilities management on the learning behaviors of students can be evaluated. The results can provide useful data to architects and facilities managers for carrying out future school projects.

## School facilities and learning behaviors

"Facilities" generally form part of the properties in an organization for supporting occupants to achieve business goals (Wes and Danny, 1999; Alexander, 1996). Facilities in an educational organization aim to provide a comfortable learning environment in which to cultivate students. To ensure that quality FM is provided in schools, Post occupancy evaluation (POE) of students is vital for construction professionals and facilities managers throughout the design, construction, and occupancy stages of building development (Ornstein, 1997; Watson, 2003). A number of different facilities, such as lighting, temperature, ventilation, noise, decoration and space management, in primary schoolhouses should thus be considered.

### *Lighting*

Lighting can be provided either naturally or artificially. Light can affect both the health and the performance of human beings. An appropriate level of lighting enhances productivity, quality, staff morale, and energy conservation. Bright light can alleviate seasonal depression (Lewy, 1982), though too much sunlight can create a painful glare for both teachers and students, especially during the summer.

### *Temperature*

There are in general two kinds of temperature:

(1) ambient temperature, which is the air temperature in the surrounding environment; and

(2) effective temperature, which is an individual's perception of the ambient temperature (McAndrew, 1993).

Temperature influences thermal comfort, which subsequently affects health, working performance, and social behavior. A room that is slightly cool is more conducive to learning than a warm room.

*Ventilation*

A good ventilation system in a room provides quality indoor air and improves the working productivity of end-users. Many studies have shown that a natural ventilated space with a maximum exposure to daylight ensures the health of end-users (Duffy *et al.*, 1992). Therefore, end-users generally prefer to stay in an environment with natural ventilation or mixed-mode systems (a mixture of natural ventilation and mechanical cooling) (Baker, 1996).

*Noise*

Sound is considered as a physical entity, while noise is a psychological concept defined as unwanted sound. Excessive noise can cause various health problems (e.g. hearing loss and high blood pressure), and can negatively affect psychosocial relationships and working performance (Lebo and Oliphant, 1968). However, too much silence (i.e. low noise level) also fails to create an optimal working environment. According to Knirk (1987), background noise (like music) with a level of about 35 decibels can maximize alertness, allow relaxation, improve classroom ambience, aid learning, and improve academic performance (Charles, 1983; Knirk, 1987).

*Decoration*

Decoration plays a critical role in ensuring a comfortable environment. A learning environment can be improved by providing appropriate furniture (e.g. cushioned chairs and cabinets for books and magazines), adjustable lighting, colorful carpets, live plants, pictures, and a bulletin board (Sommer and Olsen, 1980). In fact, students generally learn better and pay more attention when they are studying in a room painted in pleasing pastels – yellow, rose, blue, and green (Birren, 1965; McGuffey, 1982; Sharpe, 1974) – since people normally prefer light to dark colors, saturated colors to unsaturated colors, and colors from the "cool" end of the spectrum to "warm" colors (Bennett, 1977; Child and Iwao, 1969; Mehrabian and Russell, 1974).

*Space management*

Space management refers to workspace planning. In order to meet the needs of a specific business, the nature of the business, its attributes, its location, and the number of activities that it carries out have to be considered. Individuals who work in a crowded area may perform their work poorly; develop high stress, high blood pressure, or another type of illness; and experience job dissatisfaction (Cotts and Lee, 1992; Carnevale, 1992; Rose, 1994). Space growth and space flexibility are space management methods for solving the problem of crowded conditions. The construction of new millennium schools in Hong Kong sought to enlarge the space provided to each student in classrooms and allow a flexible seating plan. Edwards (2000) points out that "sitting in a circle" encourages students to work in groups, facilitates social interaction, and makes it easy to communicate, while "sitting in rows" encourages students to work individually, ensures the teacher's authority, separates students from one another, and prevents discussion. Classrooms in which students' desks are arranged in rows form an "action zone" in the front and centre portions in which greater student-teacher interaction can be enabled (Adam and Biddle, 1970). Students who sit within the action zone generally have a better attitude, tend to participate more, demonstrate better on-task behavior, attain higher achievement levels, and receive more constructive

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feedback (Edwards, 2000). In contrast, students who sit outside the action zone generally have lower self-esteem, feel more threatened, and maintain a larger personal zone. Facilities managers therefore need to arrange classroom furniture in ways that maximize mobility and minimize physical barriers in order to ensure proximity between teachers and students.

In recent years, innovative equipment, such as computers, printers, scanners, and projectors, has come to be commonly used in schools. It is believed that high technology can enable effective teaching and learning in classrooms. A "chalk and talk" lecture requires students to sit down and take notes (Mayer, 2001), but multimedia facilities allow students to actively participate in the learning process (e.g. by simulating case studies, viewing real pictures, etc.). Shelly (2002) points out that student who hears, sees, and interacts in a learning environment can retain 80 per cent of the information.

In order to ensure a quality education for students in school, school facilities have to be periodically evaluated over their life cycle. As students are the occupants of schoolhouses, the evaluation of students' comments can provide valuable feedback to architects and facilities managers for designing and managing primary school projects in the future.

## Methodology

Since 2000, Hong Kong government initiated a standard public design for public primary schools in Hong Kong (named as Millennium Primary Schoolhouse). Three Millennium Primary Schools that had moved into new millennium schoolhouses and commenced operations in the first semester of 2003-2004 were invited to join the research. To evaluate the new schools by ascertaining the views of the occupants, both pre- and post-occupancy evaluation questionnaires were administered in 2003-2004 to 750 primary students who had studied in both the old schoolhouses and the new Millennium Schoolhouses. The post-test survey was carried out three to four months after the schools had moved to the new Millennium Schoolhouses in order to ensure that the comments focused on the FM performance and the learning behaviors of the students in the Millennium Schools.

The questionnaire included three main sections:

(1) the background information of the students and the schools;

(2) the level of satisfaction with the FM performance in the classrooms; and

(3) the learning behaviors of the students in the classrooms.

The questionnaire was written in Chinese to ensure that the respondents understood it, and was distributed to all the students who studied at forms 5 and 6 in the three selected schools. Each item was rated continuously from 1 to 5, with 1 indicating totally disagree or totally dissatisfied, and 5 indicating totally agree or totally satisfied.

## Results

### *FM and LB components*

All the items in the questionnaire were found to be reliable by Cronbach's alpha ($\alpha = 0.862$ and 0.948 for FM and LB respectively). For the FM data set, the alpha value was further improved to 0.850, while items 3 and 6 were deleted. Therefore, all the FM and LB items (except items 3 and 6) were applied in the factor analyzing techniques. The FM and LB components are shown in Table I.

| | Components | Items | Factor loadings | Cumulative (%) |
|---|---|---|---|---|
| *FM (KMO = 0.861)* | | | | |
| FM1 | Space management | Furniture size | 0.775 | 11.235 |
| | | Furniture comfort | 0.731 | |
| | | Walkway | 0.625 | |
| | | Sitting arrangement | 0.585 | |
| | | Density | 0.559 | |
| FM2 | Teaching tools | Projector | 0.738 | 21.700 |
| | | Television | 0.726 | |
| | | Computer | 0.694 | |
| FM3 | Light and ventilation | Sun light | 0.752 | 31.717 |
| | | Air quality | 0.742 | |
| | | Artificial light | 0.676 | |
| | | Open window | 0.439 | |
| FM4 | Comfortable atmosphere | Cleanliness | 0.755 | 41.659 |
| | | Tidiness | 0.723 | |
| | | Facility manager | 0.554 | |
| | | Quiet classroom | 0.514 | |
| | | Broadcasting equipment | 0.434 | |
| FM5 | Supplementary facilities | Indoor plant | 0.663 | 49.984 |
| | | Bulletin board | 0.636 | |
| | | library corner | 0.533 | |
| | | Group discussion area | 0.520 | |
| *LB (KMO = 0.948)* | | | | |
| LB1 | Coordination | Work with peers | 0.807 | 12.471 |
| | | Share with peers | 0.776 | |
| | | Get involved | 0.519 | |
| | | Happy | 0.426 | |
| LB2 | Academic performance | Study confidence | 0.761 | 24.715 |
| | | Academic goal | 0.684 | |
| | | Active | 0.559 | |
| | | Less distracted | 0.412 | |
| LB3 | Attention | Relaxed | 0.742 | 36.594 |
| | | Refreshment | 0.689 | |
| | | Concentration | 0.632 | |
| | | Energetic | 0.415 | |
| LB4 | Classroom preference | Exciting in classroom | 0.788 | 48.415 |
| | | Feel time pass quickly | 0.754 | |
| | | Remain in classroom | 0.477 | |
| LB5 | Discipline | Remain in seat | 0.666 | 58.329 |
| | | Speak appropriately | 0.647 | |
| | | Calm | 0.517 | |
| LB6 | Goal achievement | Creativity | 0.777 | 66.584 |
| | | Persistence | 0.659 | |

**Note:** FM – facilities management in classrooms; LB – learning behaviors of students in classrooms. Only items with factor loading higher that 0.30 are shown

**Table I.**
FM and LB components in classrooms

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*FM and LB improvement in Millennium Schoolhouses*

In order to understand the enhancement of facilities management and the improvement in the learning behaviors of students in the classrooms of millennium schoolhouses, an independent sample t-test was used that compared FM and LB in the old and new schoolhouses (see Table II).

Table II indicates that, in the millennium schoolhouses, four out of the five FM factors were significantly improved ($\Delta$ mean = 0.264, 0.211, 0.195 and 0.162 at 1 per cent significance level), while only one type of learning behavior (study tools) was improved, and then only slightly ($\Delta$ mean = 0.059 at 10 per cent significance level).

*Changes in FM versus changes in LB*

Spearman correlation coefficients are used to analyze the relationship between two variables according to the rank of the values of each of the variables in the sample (Coolidge, 2000). To understand the impact of FM in the millennium school classrooms on the learning behaviors of students, Spearman correlation coefficients between the changes in FM and the changes in LB in the classrooms were calculated (see Table III).

The results shown in Table III are quite surprising. Most of the correlations between the changes in FM and the changes in LB are significant. "Light and ventilation" and "comfortable atmosphere" were the improved FM components those correlated with all the improvements in LB for the primary students in the classrooms, while the improvement in "coordination", "attention", and "goal achievement" were the LB components those correlated significantly with all five improved FM components ($p$-value = 0.05/0.01).

## Discussion

The correlation coefficients indicated clearly that most of the changes in the FM components were significantly related to the changes in the learning behaviors of students. Samdal *et al.* (1999) point out that the school environment psychologically influences the school climate; for example, autonomy, control, management, social relationships, and students' satisfaction. The study revealed that the environment in the millennium schools was a significant improvement over that of the old schoolhouses. This shows that the environment (comfortable atmosphere, light and ventilation) in the classroom directly affects the learning behaviors of students in terms of coordination, academic performance, attention, classroom preference, discipline and goal achievement.

In the millennium schools, "supplementary facilities" such as bulletin board, library corner, indoor plant, etc. are provided in each classroom, while the seating (space management) is arranged in circles. This encourages attention, discussion and coordination within a group (Edwards, 2000), and thus improves the students' coordination, attention, classroom preference and goal achievement. However, architects and facilities managers should redesign the layout and some facilities of classrooms in millennium schools so that students' self-discipline in class and academic performance can also be controlled and improved respectively.

Innovative technologies provide opportunities for students to view real pictures, gain practical experience, and enhance their creativity (Jeanne, 2004). Since the students in this study did not consider the changes in the teaching tools in the

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**Table II.**
A comparison of FM and LB in the old and new schoolhouses

| Components | | Pre-test (in old schoolhouse) Mean | Pre-test (in old schoolhouse) Standard deviation | Post-test (in new schoolhouse) Mean | Post-test (in new schoolhouse) Standard deviation | Mean difference | t | Sig. (two-tailed) |
|---|---|---|---|---|---|---|---|---|
| *FM* | | | | | | | | |
| FM1 | Space management | 3.476 | 0.830 | 3.737 | 0.795 | 0.262* | 8.284 | 0.000 |
| FM2 | Teaching tools | 3.499 | 0.987 | 3.493 | 0.975 | −0.006 | −0.136 | 0.892 |
| FM3 | Light and ventilation | 3.913 | 0.815 | 4.124 | 0.742 | 0.211* | 6.694 | 0.000 |
| FM4 | Comfortable atmosphere | 3.626 | 0.865 | 3.821 | 0.770 | 0.195* | 5.913 | 0.000 |
| FM5 | Supplementary facilities | 3.494 | 0.830 | 3.656 | 0.840 | 0.162* | 4.880 | 0.000 |
| *LB* | | | | | | | | |
| LB1 | Coordination | 3.826 | 0.888 | 3.840 | 0.878 | 0.010 | 0.312 | 0.755 |
| LB2 | Academic performance | 3.387 | 0.895 | 3.442 | 0.900 | 0.499 | 1.577 | 0.115 |
| LB3 | Attention | 3.440 | 0.895 | 3.506 | 0.911 | 0.059** | 1.909 | 0.057 |
| LB4 | Classroom preference | 3.026 | 1.018 | 3.065 | 1.034 | 0.032 | 0.818 | 0.413 |
| LB5 | Discipline | 3.649 | 0.906 | 3.687 | 0.889 | 0.037 | 1.091 | 0.276 |
| LB6 | Goal achievement | 3.533 | 0.998 | 3.546 | 0.983 | 0.011 | 0.292 | 0.770 |

**Notes:** * Denotes that the mean difference is significant at the 0.01 level; ** denotes that the mean difference is significant at the 0.10 level. "Pre-test" and "Post-test" represent respectively pre-occupancy and post-occupancy evaluation of the students in the millennium schools (i.e. 750 + 750 students)

| Components | | Space management (FM1) | Teaching tools (FM2) | Light and ventilation (FM3) | Comfortable atmosphere (FM4) | Supplementary facilities (FM5) |
|---|---|---|---|---|---|---|
| LB1 | Coordination | 0.140*** | 0.128*** | 0.235*** | 0.136*** | 0.157*** |
| LB2 | Academic performance | 0.065* | 0.038 | 0.150*** | 0.106*** | 0.072** |
| LB3 | Attention | 0.142*** | 0.115*** | 0.184*** | 0.190*** | 0.116*** |
| LB4 | Classroom preference | 0.082** | 0.091** | 0.112*** | 0.138*** | 0.118*** |
| LB5 | Classroom preference | 0.078** | 0.059 | 0.105*** | 0.092** | 0.054 |
| LB6 | Goal achievement | 0.082** | 0.117*** | 0.152*** | 0.127*** | 0.084** |

**Table III.**
Correlations between changes in FM and changes in LB in the classrooms

**Notes:** * Denotes that the mean difference is significant at the 0.10 level; ** denotes that the mean difference is significant at the 0.05 level; *** denotes that the mean difference is significant at the 0.01 level

millennium schools to be significant, architects and facilities managers need to reconsider the requirements of tools from the point of view of the teachers.

The study indicated that five out of the six learning behaviors of the students had no significant change, but it still clearly showed significant relationship between the changes of FM and the changes of LB of students in millennium schools. Therefore, the study still reflects the relationship between the FM in schoolhouse and the LB of students. Perhaps, a long-term study on the learning behaviors of students is required in order to reveal the impact of new schoolhouse clearly.

## Conclusion

The classroom is a key area for cultivating students (one of the main occupants in schoolhouse). This occupancy evaluation study identified five major FM components in classrooms (space management, teaching tools, light and ventilation, comfortable atmosphere and decorations and communication) and six LB components of primary students (coordination, academic performance, attention, classroom preference, discipline and goal achievement). All the FM components except teaching tools were significantly improved in the millennium schools, but most of the LB components showed no changes. A long-term study on the learning behavior of students in new schoolhouse is recommended for further study.

However, the study revealed that most of the improved FM components correlated to the enhanced LB of the students in the millennium schools. It indicates that facilities management is one of the main factors for improving the learning behaviors of primary students in this study. Architects and facilities managers should further discuss with teachers about how to encourage students in classrooms to be self-disciplined, redesign the layout, and reconsider the teaching tools that today's primary students need. It is suggested that a longitudinal POE study be conducted in these three millennium schools in order to understand the long-term impact of facilities management in millennium primary schools, especially the impact on the academic performance of students.

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