Impacts of Space and Furniture Design on Student Learning

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Abstract

The traditional teacher-centered teaching mode in tertiary education concerned primarily with one-way delivery of information to students. Teaching is usually confined to lecture theatres and general teaching rooms, which are designed to "one size fits all". With the increasing integration of communication and information technologies, and the emergence of the constructivism-learning paradigm, teaching and learning have shifted from the traditional 'passing expertise knowledge to students' to 'interactive learning between teachers and students, and among students' advocated in contemporary teaching. The traditional classroom design, which is focused on teachers' performance, cannot support collaborative learning effectively. The design should be student-oriented, which is particularly important in the self-financing tertiary education sector as students are the main users of the facilities provided in campus. Hence, facilities that encourage learner participation are increasingly important in learning space design. Previous research suggests that such parameters as functionality, versatility, aesthetic and comfort should be included in learning space design in order to achieve effective teaching and learning. Learning spaces should also be equipped with advanced IT/AV facilities to supplement and inform effective teaching. Classrooms are even preferable to be multi-functional adapting to different uses and contextual needs whereas furniture should be flexible allowing quick reconfiguration to facilitate group discussions and activities.

This research is based on the Strategic Plan 2012-18 of The Hong Kong Polytechnic University, which includes upgrading and creating innovative learning spaces and facilities with a view to improving the learning environment. Design and innovations have been embedded to make a difference. Vibrant colour is added to classroom design for motivating learning incentive. Ambient lighting and adjustable temperature are provided to create a comfortable environment for awakening learning. The modular tables and mobile chairs further enhance instant movements and formation of different sizes for group discussions to facilitate active learning. The overall design is able to generate interaction, collaboration, physical movement and social engagement as primary elements of student learning experiences to satisfy the strong desire of students nowadays. Questionnaire Surveys to collect students' feedback on completed renovation works were conducted to review the effectiveness of the alterations. Students are generally satisfied with the renovation work, agree that the refurbished teaching rooms have achieved the purpose of renovation, and enhance active learning. This paper summarizes the survey findings and draws conclusions on how space and furniture design can facilitate collaborative learning for consideration of creating effective learning space by the self-financing tertiary education sector.

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1. Introduction

Modern technologies have brought about changes in pedagogy. The increasing application of communication technologies in teaching has caused the shift of traditional teacher-centered teaching in tertiary education to student-centered and flexible learning approaches [1] [2] [3]. It is important that the provided facilities can encourage student participation [1]. Extensive use of internet as a teaching media has extended teaching spaces from formal classrooms and lecture theatres to the whole campus [1].

This paper studies the recent changes in pedagogy and the influence of modern technologies on learning space design. The renovation project of the classrooms and lecture theatres of The Hong Kong Polytechnic University will be used as a case study.

2. Traditional Pedagogy

Learning is the central activity of tertiary education and includes formal learning in classrooms/lecture theatres and informal learning involving interaction among individuals [4]. Traditional teaching is based on teacher-centered teaching mode that concerns primarily with one-way delivery of information to students [1]. Learning space design is focused on the delivery of information from teachers to students. The teaching lectern is the focal point of the teaching space and students are orientated towards it. Comfort and ergonomics are the main considerations in furniture design.

3. Influence of Modern Technologies on Pedagogy

3.1 Emergence of modern technologies

Modern technologies has induced tremendous changes in our society from industrial economy to knowledge economy [5], which also initiated pedagogical changes. Information and telecommunication technologies have become an effective tool for access to graphics, sound, presentation and real-time interactive communications that provide a vast array of teaching opportunities for teachers [6] [7]. The increasing ownership of digital devices like computer notebook has enriched learning method [8]. Integration of communication and information technologies shift teaching as teacher-centered practices with primarily one-way delivery of knowledge to students to student-centered and flexible learning approaches [9]. Learning becomes an active constructive process and students are becoming more responsible for their own learning [9]. Students' active participation and interactivity; multiple roles (as listener, critics, mentor, presenters); and social engagement (such as group work); and discussion boards are playing important roles in tertiary education [2].

3.2 Built Pedagogy

Space is formed by "shape and identity of the relationship created within it" and implies a certain order [10] [11]. Learning space can create an impact on learning approaches [4] [10] [11]. Built pedagogy is the ability of space that defines the teaching mode [4]. Well-designed learning space can facilitate and enhance active/collaborative learning; provide an environment to students for academic and social purposes; and promote the use of provided facilities [12]. The design should be user-centered taking into consideration of (a) functionality (flexibility and adaptability); (b) user-friendliness; (c) comfort; and (c) aesthetic [5] [12] [13]. Classrooms should be designed to bring together technology, content and services in a physical setting, which can facilitate students to collaborate with other; to be equipped with a variety of

technologies in supporting computer activities; enhance group work in different sizes; allow flexibility and support multifunctioning of the learning spaces [12]. Ubiquitous power sockets should be provided [6] to provide power for a variety of modern technologies (including computers, projectors, smartboards, video editing equipment and video conferencing) [2] [12]. Teachers should be able to move close to student and walk freely around the classroom to engage individual students without physical obstacles [14].

Flexible furniture should be provided to facilitate group activities in different sizes [11] [14]. Modular tables (Fig. 1) facilitate speedy reconfiguration enabling multiple use and transformable layout [6] [13] [14] [16]. Chairs are preferred to be mobile on wheels to facilitate grouping, which should be designed with flexible back, adjustable seat height and adequate foam support for personal comfort [5]. Ambient lighting, good sound insulation and adjustable interior temperature can provide a comfortable environment for learning. Lively colors, interesting textures and patterns can motivate learning [12] [16].
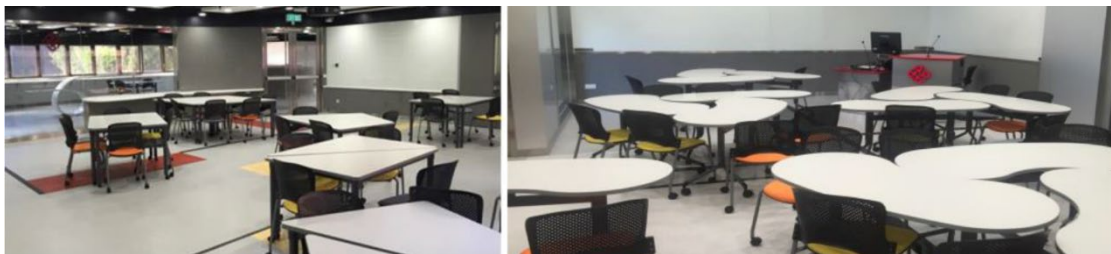

Fig. 1 Modular tables

4. Strategic Plan 2012-18 of The Hong Kong Polytechnic University
4.1. Background
The Hong Kong Polytechnic University has implemented The Strategic Plan 2012-18, which involves updating, upgrading and creating innovative learning spaces and facilities aiming at improving the learning environment. Upgrading, refitting and revamping work on some classrooms and lecture theatre have been carried out since summer 2014. Questionnaire Survey was conducted in spring 2018 to collect students' feedbacks on the renovation for reviewing the effectiveness of the renovation project.

4.2. Scope of renovation work
Traditional teaching rooms were transformed into modern and technology-enhanced rooms to facilitate interactive and student-centered learning. Spaces were redesigned, reconfigured or combined to support different sizes of teaching groups. Upgraded IT/AV facilities, new lectern design in vibrant colours, multiple monitors, flexible furniture and more writing surfaces for interactive learning were installed creating a more comfortable learning atmosphere. Multiple monitors can show information from different sources. New lectern, projection screens and wall-mounted whiteboards were added to allow flexibility for interactive and conventional teaching. Comfortable, flexible and movable furniture (Fig. 2) were provided to enhance grouping. Interior is designed for comfortable learning. Vibrant colour elements in the decoration, such as patterned flooring (Fig. 3), were introduced to promote learning incentive. Interior illumination is improved by allowing users to adjust lighting level.

Fig. 2 Movable furniture

Fig. 3 Vibrant flooring

In classrooms N101/102/103, movable glass partitions are used to reconfigure the three classrooms into different sizes to facilitate different types/sizes of group activities (Fig. 4). A glass wall is used in BC404 to brighten up the room (Fig. 5).
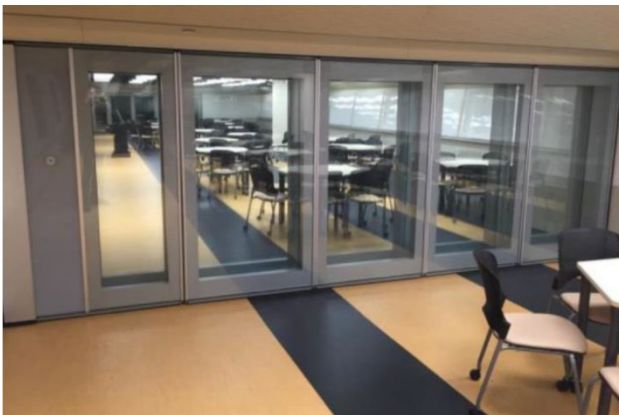

Fig. 4 Movable glass partitions

Fig. 5 Glass wall

Lecture theatres were refitted into modern, comfortable and technology-enhanced teaching spaces to facilitating active learning. Multiple monitors were installed in N001/002/003 for better visibility (Fig. 6). Double swirl chairs were installed in TU101 and 103 to facilitate grouping and interaction among students (Fig.7).

Fig. 6 Multiple monitors in N001

Fig. 7 Double swirl chairs

5. Assessment of Strategic Plan 2012-18

5.1. Questionnaire survey

Questionnaire survey was conducted to collect students' comments on the performance of the refurbished classrooms and lecture theatres in assisting active learning. Five hundred copies of questionnaire were distributed and 402 completed copies were collected with 80% return rate. The questions are categorized into six sections, which relates to how the applied technologies, space design, comfort of learning space, and aesthetic design can promote learning; and the importance of developing an assessment system to evaluate the effectiveness of teaching space design. Students were asked to rank the performance of the renovated rooms in the last section. A copy of the questionnaire is attached at Annex 1.

5.2. Overall performance of the refurbished teaching rooms

Application of modern technologies can promote active learning. Installing computers, projectors, smartboards, video auditing equipment, video conferencing, 3D visualization, etc. can enhance learning. The provision of plug-n-play (access to technology, ubiquitous power and data connection) is useful; and students can easily present, modify, record and retrieve information by using the provided facilities.

The new layouts are adaptable for multiple uses and the space designs facilitate group discussion. The flexible furniture design allow easy reconfiguration of grouping in different sizes. The provided furniture is comfortable and enhance concentration in learning. The acoustic of the rooms are satisfactory and improve students' concentration. Lighting is ambient. Students prefer adjustable lighting level, which can enhance learning. They neither agree nor disagree that the interior temperature of the renovated rooms is comfortable. Students agree that the ability to adjust interior temperature is important to learning comfort. The created environments are comfortable and enjoyable. The use of vibrant color elements can motivate learning.

To develop an appropriate assessment system for periodic review on the effectiveness of space design is important for long-term development of improving learning environment.

Conclusively, students are generally satisfied with the renovation work. They agree that refurbished teaching rooms can achieve the purpose of renovation and enhance active learning.

The new design emphasizes interaction and collaboration among teacher and students, which can facilitate students to collaborate with others, support increased emphasize on group work, and equipped with a variety of technologies to facilitate presentation.

The survey findings are summarized in Table 1 and Figure 7.

Table 1 Students' comments on Strategic plan 2012-18

|	Improvements Work	Comments from students
1.0	**Application of modern technologies**	
1.1	Upgraded IT/AV facilities	Agreed
1.2	Access to technology, provision of ubiquitous power and data connection	Agreed
1.3	Ease of using the provided facilities	Agreed
2.0	**Flexibility in space design**	
2.1	The learning space is designed for multiple uses	Agreed
2.2	Space design facilitate group discussion	Agreed
2.3	Use of flexible furniture can facilitate grouping in different sizes	Agreed
3.0	**Comfort**	
3.1	The chairs with flexible backs and adjustable seat height is comfortable and enhance concentration in learning	Agreed
3.2	The acoustic of the room is satisfactory and improve concentration	Agreed
3.3	Lighting is ambient	Agreed
3.4	Adjustable lighting level can enhance learning	Agreed
3.5	The interior temperature is comfortable	Agreed
3.6	Ability to adjust interior temperature is important to learning comfort	Agreed
4.0	**Aesthetic**	
4.1	Are flexible furniture comfortable?	Agreed
4.2	Can the use of vibrant colour promote learning incentive?	Agreed
4.3	Does the interior design create a comfortable environment for learning?	Agreed
5.0	**Assessment**	
5.1	Setting up assessment	Agreed
5.1	Conducting periodic assessment	Agreed
6.0	**Overall Performance**	**Agreed**
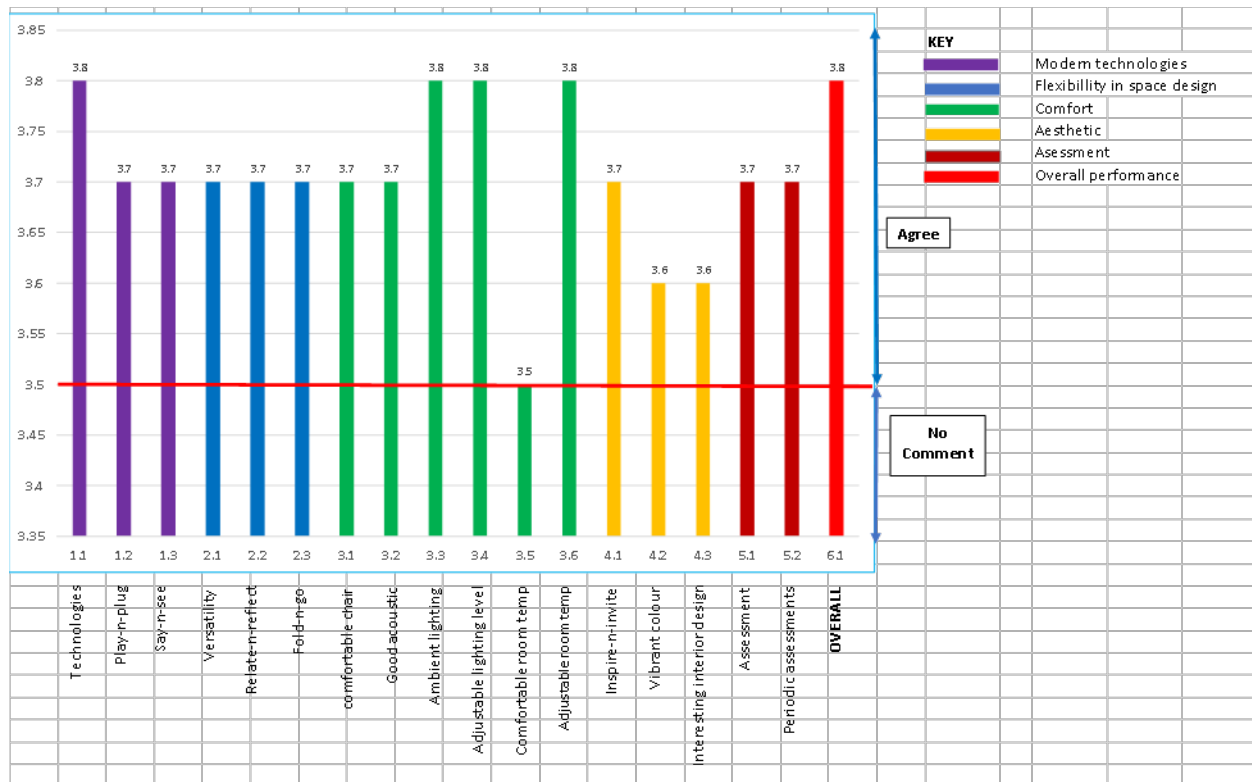
Fig. 7 Summary of questionnaire survey findings

6. Conclusion

Application of information and telecommunication technologies in tertiary education have induced pedagogical changes. Active learning, which emphasizes collaboration among students play a major role in learning. Teaching mode shifts from teacher-centered to student-centered. Traditional learning space design cannot facilitate active learning. A new design concept of "Built Pedagogy" evolved. Learning space design focused on facilitating interaction among students and students' satisfaction on the performance of the teaching room. A user-centered classroom is functional, user-friendly, comfortable, psychological appealing and facilitates interaction among students. The new design should be comfortable, enhance safety and health of users and support information technology. Interior design can create a comfortable environment and motivate learning. Furniture design should be flexible and multi-functional, which allow quick reconfiguration for grouping.

The Hong Kong Polytechnic University has implemented the Strategic Plan 2012-18 to refurbish some conventional classroom/lecture theatres into active learning spaces. Questionnaire survey was conducted to collect students' comments on the performance of the newly refurbished classrooms and lecture theatres. Generally, students are satisfied with the refurbishments. The findings can be used as reference to design or renovate teaching spaces in self-financing tertiary education sector, which are mainly funded by student fees.

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7. Acknowledgements

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Impacts in Learning Space on Teaching and Learning Effectiveness (Student Survey)

Active learning emphasizes interaction and collaboration among teacher and students. Learning space design can facilitate students to collaborate with others, support increased emphasize on group work, and equipped with a variety of technologies to facilitate presentation.

This survey aims to collect your comments on the performance of the classroom/lecture theatre in assisting active learning based on your learning experience. Your comments will help update, upgrade and create innovative learning spaces and facilities at PolyU, and drive innovations and improvements in our learning and teaching environment.

Part A – Space Design
Please rate the your degree of agreement with the following statements by ticking the appropriate box.
[5 = strongly agree; 4 = agree; 3 = no comment; 2 = disagree; 1: strongly disagree]

		5	4	3	2	1
1	**Modern Technologies**					
1.1	The equipped *technologies* (e.g. computers, projectors, smartboards, video auditing equipment, video conferencing, 3D visualization, etc.) enhance learning	☐	☐	☐	☐	☐
1.2	The provision of *plug-n-play* (access to technology, ubiquitous power and data connection) is useful	☐	☐	☐	☐	☐
1.3	*Say-n-see*: You can easily present, modify, record and retrieve information by using the provided facilities	☐	☐	☐	☐	☐
2	**Flexibility in Space Design**					
2.1	*Versatility*: The learning space is designed for multiple uses	☐	☐	☐	☐	☐
2.2	*Relate-n-reflect*: The space design facilitates group discussion	☐	☐	☐	☐	☐
2.3	*Fold-n-go*: the furniture can be easily reconfigured to facilitate grouping in different sizes	☐	☐	☐	☐	☐
3	**Comfort**					
3.1	The chairs with flexible backs and adjustable seat height is comfortable and enhance concentration in learning	☐	☐	☐	☐	☐
3.2	The acoustic of the room is satisfactory and improve concentration	☐	☐	☐	☐	☐
3.3	Lighting is ambient	☐	☐	☐	☐	☐
3.4	Adjustable lighting level can enhance learning	☐	☐	☐	☐	☐
3.5	The interior temperature is comfortable	☐	☐	☐	☐	☐

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3.6	Ability to adjust interior temperature is important to learning comfort	☐	☐	☐	☐	☐
4	**Aesthetic**					
4.1	*Inspire-n-invite*: the environment is comfortable and enjoyable	☐	☐	☐	☐	☐
4.2	The use of color is can motivate learning	☐	☐	☐	☐	☐
4.3	The textures, patterns and finishing are interesting and motivate learning	☐	☐	☐	☐	☐
5	**Assessment**					
5.1	Develop useful assess methods to review effectiveness of space design is important	☐	☐	☐	☐	☐
5.1	Periodic assessments to review effectiveness of space design is important	☐	☐	☐	☐	☐
6	**Overall Performance**					
6.1	The overall design of the room can enhance active learning	☐	☐	☐	☐	☐

Part B – Background Information

B.1 You are:
( ) A. Higher Diploma student
( ) B. Bachelor Degree student
( ) C. Taught Postgraduate student
( ) D. Research Postgraduate student

B.2
( ) A. Year 1
( ) B. Year 2
( ) C. Year 3
( ) D. Year 4
( ) E. Year 5
( ) F. Year 6

B.3 What is your Department or School? ……………………………………………….

B.4 Your email address: ……………………………………………………………….

**** End of survey – Thank You ****

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