

Trends and impacts of the BYOD on the Learning Spaces design: an international comparative approach

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Abstract: The Bring Your Own Device (BYOD) massively involved in the Learning Spaces phenomenon, effectively represents a key transformation factor on the institutions' IT, and on the teaching and learning practices. Nevertheless, from countries to other ones, and beside obvious similarities, interesting differences – some of them culturally related – are observed in the BYOD implementation inside the Learning Spaces. This paper uses an international comparative study's first results to address the BYOD topic applied to Learning Spaces design around the world.

Keywords: BYOD, Learning Spaces design, Active Learning Classrooms, Learning Commons, international comparative study

1. Introduction

Since more than 10 years now, the Learning Spaces became a continuous increasing hot topic in Higher Education [1]. First built around Active Learning Classrooms, the trend then moved to involved larger and integrated spaces as the Learning Commons (Fig. 1), often considered to be a new generation of University Libraries, or the Learning Centers.



**Fig. 1 Kyoto University
Central Library Learning Commons**

An international comparative study of Learning Spaces (Active Learning Classrooms, Learning Centers, Learning Commons) launched in October 2016 is currently conducted through a collaboration between Kyoto University and Paris Ile-de-France Digital University. Already involving 40 institutions on 4 continents, and including international workgroups such as EDUCAUSE/ELI ones [2], this project seeks to study the Learning Spaces phenomenon through different angles: policies, trends, design principles, outcomes on teaching and learning practices, and more globally on campuses transformation.

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This paper presents the study framework, the criteria used, and within them, and makes a particular focus on the BYOD, as a fundamental and impacting component of the Learning Spaces design.

It then focused of the BYOD integration in the institution IT environment, and finish by a first comparative analysis between the Japanese situation and the European and American ones.

2. Framework of the study

The study address a sample of institutions in Europe, North America, Canada, Japan, Singapore and Australia. We seek to make this sample as significant as possible, by including national and private universities (when this double status exists), big (>30.000 students) and smaller (<10.000 students), sciences focused and humanities focused ones, and located in various regions in each country.

Beside the variety, the selection of universities in the sample was based on existing or upcoming Learning Spaces, integrated in an institution campus strategy. At the time of this paper's writing, the Japanese sample includes 12 universities are already participating.

The methodology consists of collecting quantitative and qualitative materials through visits, interviews stakeholders (managers, designers, faculty users, student users), and observations on site.

We intend to use these data, feedbacks and experiences to identify similarities and differences among spaces designed for identical purposes, in the different countries and institutions. From the study of the spaces themselves and the uses/practices they effectively induce, we seek to conduct a reverse analysis first to highlight the design purposes, and above the institution's strategy that was applied in this project. This to outline the conditions of the Learning Spaces success conditions, and the potential of a large scale generalization.

This paper focuses on the first trends observed from EU, North America and Japan, and intend to compare the Japanese situation regarding the Learning Spaces to the two other territories.

2.1 Study's criteria

The study itself is based on a list 10 major criteria, chosen as the address the Learning Spaces not only on their material point of view, but also on the induced (or not) practices, and on their genesis, their governance, their motivations, and their integration in the campus context.

- Terminology: What type or spaces are precisely defined by the terms Active Learning Classrooms, Learning Commons and Learning Centers ? What are their key features ?
- Layout and furnishing: What type of spatial organization and what type of furnishing (fixed, mobile, mixed) are chosen for the spaces ?
- Integrated IT/ICT: What kind of IT/ICT equipment are installed inside the Learning Spaces (displays, video sharing systems for example), and outside (online reservation system or distance monitoring for example) ? Globally, are they designed in a high-tech approach ?
- BYOD compliancy: Are the Learning Spaces designed to be BYOD compliant, and if so, are they a part of the institution's BYOD strategy ?
- Location on the campus: Are the Active Learning Classrooms gathered in a centralized location ? Is the Learning Commons located inside or outside the library ?
- Governance of the project: How the Learning Spaces project has been integrated in the context of the campus, and in the institution's strategy ? Is it a institution-wide or a local (faculty) initiative ?
- Design and evaluation tools: Did the project team use design and evaluation tools before and after the spaces opening (Learning Spaces Rating System [3], FLEXspace [4]) ?
- Community interactions: Are the uses of the Learning Spaces affected by the life style of the students, especially regarding Learning Commons opening hours for students living on the campus itself ?
- New services: In the case of Learning Commons and Learning Centers, what kind of new services are provided compared, for example, to the former University Library ?
- Teaching and Learning Practices: Do the Learning Spaces have an impact in terms of changing the practices of the faculties using them (active learning), or the learning practices of the students (collaborative work) ?

Among this list, this paper intend to have a specific focus on one of these criteria: the BYOD compliancy, its connections with other criteria, and its impacts on the Learning Spaces design.

2.2 BYOD as a key factor

The BYOD indeed appears to be one of the most potentially impacting criteria in the Learning Spaces strategy and design, with numerous connections to the other ones. Integrating the BYOD concept in a Learning Space design process, whatever could be its form, especially has very direct consequences on

layout and furnishing (especially because of mobile device compliant furnishing an spatial organization), on the integrated IT/ICT level (regarding wired and wireless network and video connectivity, and above that a BYOD compliant IT infrastructure), on the governance of the project (if the BYOD and Learning Spaces are jointly included in the institution strategy), on the new services (especially established to comply and complete the users devices: for instance technical help desk) and of course on the teaching and learning practices (by involving more interactions between the teacher and the students through digital tools and contents).

3. BYOD and impacts on the Learning Spaces design

3.1 Fixed PCs

First and most obvious consequence of the BYOD trend is the on-going removing of the fixed PCs not only in the classical PC labs, but also and mainly in the most innovative Learning Spaces.

In almost all the Active Learning Classrooms that have been visited in North America, Europe and Japan, fixed PCs have totally disappeared, also because of the furniture specificities explained in the chapter 3.2 bellow.

The situation in the Learning Commons and the Learning Centers is slightly different: if large PCs areas free to use for the students are tending to be removed, some fixed PCs areas still remaining on precise purposes are observed, as the installed machines present specific features, such as A/V producing workstations [5] located in a specific zone.

3.2 Flexible and collaborative furniture

Flexibility and collaboration appear to be one of the most basic features of Learning Spaces. Many authors and papers mentioned this flexibility as a key to the switch to an Active Learning configuration [6], and/or to promote collaborative work among the users. The choice of furniture type, and the layout design reflect those feature, through two main types of spaces.

The first type is based on highly moveable furniture, providing a lot of flexibility in the organization of space. Those furniture don't integrate any specific technology (power supply, video connection).

The second type is based on fixed tables, usually designed to promote collaboration by proposing a design allowing all the group's participants to see each other, and by providing specific features such as wired networking for specific purposes, power supply, and shareable displays.

Even though both of those configurations are systematically compliant with the BYOD, in the case of an Active Learning Classrooms, a choice had to be made between the two of them. And even if the flexible one is often representing the typical Active Learning Classrooms, a significant number of the second type also exists (see chapter 4.3), sometimes differently named (collaborative room) keeping a significant popularity among students seeking for group work facilities.

But in a larger integrated Learning Space such as a Learning Commons, a co-existence of both can – and usually is – established. Introducing so the notion of zoning, in which different under categories of Learning Spaces, presenting different features for different kinds of practices, are existing in a single integrated structure, as functional units.

3.3 WiFi

The concept of the BYOD itself is directly related – and dependent - to an efficient WiFi network connectivity.

Beside the density and the bandwidth matters, requesting to install a sufficient number of up-to-date WiFi hotspots, the security and authentication questions remain central.

By definition, a BYOD device, its OS, the user's software, apps and contents aren't controlled by the institution's IT service, potentially representing a breach.

Moreover, Learning Spaces can typically be welcoming users not belonging to the institution, an authentication system for guest has to be provided (for instance Eduroam).

3.4 Displays & Video sharing features

Many Active Learning Classrooms present wired and wireless video sharing capabilities, allowing new teaching and learning interactions, and especially able to support specific active learning purposes (Fig. 2).



**Fig. 2 Paris Ile-de-France Digital University
BYOD Faculty Development Active Learning Classroom
in Paris 8 University's Library
(shareable displays on each collaborative table and HDMI
network between the tables and the presenter screen)**

On the technical point of view, and due to the heterogeneity of systems and platforms inherent to the BYOD, these video sharing features often make necessary to use multiple systems in parallel.

Wired connections have to comply with multiple types of video outputs on the laptop and the tablets (VGA, HDMI, mini-HDMI, Video Display, mini Video Display...). Wireless video sharing systems have also to deal with different types of protocols (AirPlay, MiraCast, Google Cast), potentially requesting to multiply the types of receptors to be compliant with all types of devices. In some examples, this challenge is addressed by the universities central IT by providing a list of

features (including the type of wired/wireless connection system) suggested to the users before they buy their device.

Due to this heterogeneity, and because of spontaneous practices of the students, it's interesting also to note that analog writable surfaces remain very popular and very present in the Learning Spaces, beside digital displays.

3.5 Power outlets and charging stations

As for the WiFi previously discussed, power remains as a very basic yet fundamental issue when having an intensive use of mobile devices. One day long autonomy is clearly not a reality for number of devices, making necessary to provide battery charging solutions, especially in the Learning Spaces where their use is potentially intensive.

As mobile furniture typically use in flexible spaces don't allow to integrate power supply, such equipped Learning Spaces can have charging areas along a wall, or simply electrical racks lying on the ground. Fixed furniture, on their side, almost systematically integrate power plugs for the users.

In integrated spaces such as Learning Commons and Learning Centers, power plugs are especially present in informal and relaxing spaces, also sometimes in dedicated charging lockers.

3.6 Technical support

The conjunction between the BYOD and the Learning Spaces also introduces new modalities in terms of technical support and user assistance.

Within the new types of services provided for example in the Learning Commons, 1st level technical assistance desks or counters (previously provided at the IT department) appear to be one of the most popular (and useful) ones [7]. They can also combine a mission of technology lending, allowing the users for example to borrow accessories for their device in a BYOD situation [8].

Beside the logistic matter, these services obviously involve HR ones.

3.7 Teaching assistance

The collaborative features of the Learning Spaces appear to be one of the most attractive to the students, making them very popular for group work. The mobility induced by the BYOD, and the fact that there is a continuity in the device used on the campus and at home, makes pedagogical assistance service as relevant as compliant.

In a huge majority of the visited Learning Commons and Learning Centers, a pedagogical support / teaching assistance counter is proposed on a daily or weekly basis [9]. Such service allows for example undergraduate students to get topical mentoring from graduate students, on site and face-to-face.

3.8 Relaxing and informal areas

In their usual zoning, the Learning Commons and the Learning Centers systematically integrate relaxing areas, that also constitute in practice informal learning spaces. Those versatile areas are very popular among the students as they usually are the only ones of this style on the campus.

They contribute to give to the Learning Commons and the Learning Centers a component of informal student life

(promoting socialization), especially compliant with the BYOD. That's the reason why the type of furniture chosen for such areas are not only comfortable, but also integrate power plugs for many of them (Fig. 3.).



**Fig. 3 University of Washington
Odegaard Library 1F**

4. Specificities and similarities across countries

4.1 Types of BYOD

The Japanese part of the study immediately shown a quite unique situation, introducing the BYOPC concept beside the BYOD itself. Indeed, the smartphone – and not the laptop or the tablet – is clearly identified as the primary device for Japanese students. And even if the laptop or tablet equipment rate is as high as the European and North American ones, the Japanese students habits are to only bring the smartphone on the campus. That's why some universities, which initiated western BYOD-like policies introduced the BYOPC concept [10], as their challenge is to create a physical and digital learning environment that would motivate the students to finally bring not only their smartphone, but also their laptop or tablet on the campus (see chapter 4.2) instead of using the institution's fixed PCs. The study also outlined in Japan an important rate of PC lending service, especially in the Learning Commons.

In Europe and in North America, the use of the acronym BYOD is clearly connected to laptops and tablets, and not to smartphones. Meaning that a BYOD compliant Learning Space design is focused on the use of user's laptops and tablets in the space, through the features previously described.

A more recent trend, especially discussed in North America, is now the BYOE (Bring Your Own Everything) [11] which consists for the users not only to bring a device, but an entire personal computing environment, including the devices, the software, the apps and a cloud based environment.

4.2 Reality and institutional context of the BYOD

First results of the study show that the BYOD is definitely integrated in the Learning Spaces projects usually from their very beginning (to follow a users' promoted BYOD trend, or to initiate/support an institution trend), and clearly not just as a feature. Nevertheless, the study shows significant differences in

the origin of the BYOD trend between Japan on one side, and Europe/North America on the other.

In Japan, and regarding the cultural practices of the students described in the chapter 4.1, the switching from the current smartphone-based BYOD to BYOPC appears to be an institution initiative, rather than a spontaneous user trend. Practically speaking, and in significant examples [12], those institutions initiatives are cloud based applications servers allowing users to access a selection of software regardless the type of their device (laptop, tablet), through a Virtual Desktop Infrastructure (VDI) in most of the cases. This type of services, beside the incentive they represent for the students to bring their own device on the campus, are logically motivated by a reduction of the costs (fixed PCs replaced by the VDI infrastructure) and by an efficiency of the licensing management.

In France, the situation is quite opposite, as the move has been initiated by the end users. The BYOD was indeed a reality before such applications/software delivery infrastructures, being a motivation to run them, beside the same cost efficiency challenge than the Japanese universities. One of the major specificities of the French situation regarding the personal equipment was the government led "Student Laptop Program" [13] run from 2005 to 2009 by the French Ministry of Higher Education and Research. This program consisted of specific hardware/software/services offers directly and nationally negotiated with the industry, combined with call for proposals and financial incentives towards institutions to support this upcoming BYOD by generalizing WiFi networks (2005), establishing user support & assistance counters (2006), enabling access to digital learning contents (2007) and proposing IT training workshops to the students (2008). At a time when the average price of a laptop was significantly higher than today, this program helped to rise the equipment rate to 90% before the 2010's. Culturally speaking, it appears that the French students strongly intend to make profits of their investment into a laptop by systematically bringing it on the campus for their daily learning (and not) activities. Regarding a BYOD supporting cloud based initiative, a wide range Proof of Concept of a regional and mutualized Higher Education cloud infrastructure has been run by the Paris Ile-de-France Digital University from 2012 to 2015 [14], opening the way to a nation-wide solution (as the French Higher Education system, almost only composed of national universities, strongly promote such kind of mutualizations).

US universities also integrated the BYOD quite early, as the students' equipment is supported by an almost systematic presence of a university store/coop on the campus, proposing negotiated hardware and software offers to the students. As the typical way of life of the students in the US is to live on the campus itself, the BYOD is virtually a non-question: the personal equipment is already on the campus with its owner. There isn't any issue related to transportation from home to the campus. Visiting the US universities clearly confirm this: almost all the students spent their entire day with their own laptop, in the lecture halls, the classrooms, the libraries and outside.

As a consequence, in Europe as in USA, PC lending service in the Learning Commons aren't as much important as in Japan, except for the tablets (that can be considered as a secondary device not systematically owned by the students) and for digital accessories for specific purposes.

4.3 BYOD and Active Learning Classrooms design

First, the study already shows that the BYOD is clearly a core component of Active Learning Classroom design in Europe, North America and Japan. In all territories, the situation is similar: all types of Learning Spaces, and especially Active Learning Classrooms, integrate the BYOD at the very first steps of their conception.

But as mentioned in chapter 3.2, and for supposed to be identical purposes, the BYOD in Active Learning Classrooms design can be reflected mainly in two ways: flexible, or fixed furniture. Beside, the integrated IT/ICT shows variations from an example to another. From high-tech to less technologically equipped ones, almost all the specter of Active Learning Classrooms can be observed in the three territories. Those variations also exist between flexible and fixed furniture one.

The correlation observed between the territories and those two factors (flexible/fixed & high-tech/low-tech), is limited, yet real. We can mention that heavily fixed furniture Active Learning Classrooms are less observed in Japan, where flexibility appears to be more systematic, in a space optimization state of mind, by allowing a number of configurations as numerous as possible. In North America, really low-tech Active Learning Classrooms are almost not observed.

Regarding this low-tech trend, it's necessary to mention that it hasn't any correlation with the outcomes on the uses and on the practices. Some very interesting ones has been observed in facilities where the technological equipment wasn't a priority. Indeed, this choice is made in several cases on a purpose of human communication focus (rather than the use of digital tools), and not only because of budget restrictions.

4.4 Software/apps policies

Integrating the BYOD in the Learning Spaces design is impacting not only in terms of IT infrastructure compliancy (see chapter 3.3), but also regarding the software and applications providing and deployment. The study highlights different strategies, with some geographical connections.

The usual and more simple situation consists of negotiated offers for software, provided through the university store/coop, and/or through the institution's website. This configuration is mainly observed in North America and Europe. It doesn't involve any deployment and licensing management issues, as they stay under the users' responsibility.

The second way is involving campus wide licensing, contracted by the institution itself, allowing all the users to get software regardless the device they use. Common in Japan and North America, this solution is evolving since some year through the campus wide cloud based solutions that could be contracted from different major IT actors of the market.

The third solution, which appears to be the most compliant to large scale BYOD initiatives, use Virtual Desktop Infrastructure (VDI) architecture to provide not only software, but a global environment, regardless of the device. This solution also preserve a higher control of software licensing and configuration from the IT department. This choice is almost systematic in Japanese BYOD projects, getting increasingly popular in North America, and yet to adopt in Europe.

5. Concluding Remarks

This first step of the study confirmed a fundamental assertion: Learning Spaces AND BYOD are – together - more than a temporary trend. In all territories, they clearly move in synergy, promoting (and sometimes justifying) each other.

Looking back to the Learning Spaces design principles related to the BYOD and that have been the core focus of this paper, it appears that the material aspects (embedded technology, layout and furnishing) don't really tend to homogenize, still reflecting some of their respective territories' cultural aspects. For instance, Japanese Learning Spaces, in their core design, apply the same space optimization process than usually applied in any other construction. North American Learning Spaces, on their side, involve more systematically an important amount of embedded technology. Globally, the same types of purposes can be translated in quite different material realities, without a genuine universal recipe.

Nevertheless, and despite those territories differences, Learning Spaces' basics in design remain the same. Also because the material aspects don't make a significant difference in terms of uses and practices from a country to another. The evolution of the battery capacity, for example, will identically impact the necessity – or not – to provide power slots in all territories' Learning Spaces. As well as the evolution of the furnishing, that is globalized.

But on the macro level, really significant and impacting differences are much easier to highlight. In particular, the bottom-up approach (users' initiative) that has promoted the BYOD in Europe and North America really contrasts with the top-down (institutions' initiatives) observed in Japan.

Strategically speaking, the decision process, the involvement of key actors, and the integration in a global campus strategy appears to be definitely a key to move from a local – yet interesting – project for example run by a team of faculties, to a real game changer for the institution. Likely, a real evolution of the practices in such new spaces in deeply connected to a strategic pedagogical vision and to a Faculty Development initiative that is obviously necessary in such a context. And so, at least as much as any material feature or specificity.

The next steps of this study will especially try to identify those success factors, and their potential of transposition between countries.

The interpretation of those similarities and those differences

also invites to go beyond the border of our campuses. The uses of the Learning Spaces as the practice of the BYOD, should they already be established or not, are fed not only by the cultural aspects of each territories, but also by the trends of their respective societies facing the digital evolutions. Integrating more or less the BYOD in a daily practice can for example be influenced by a cultural separation between the private life and the student/professional life. On the technological evolution point of view, the use of the smartphone as a primary device in Japan constitutes a challenge in a BYOPC strategy today, but could also be considered as a forecasting situation to reconsider in few years by the other territories.

For an institution, the motivations of a Learning Spaces / BYOD strategy can be various. But basically, beside the obvious and legitimate visibility they give to an institution, especially in the more competitive Higher Education systems, the promises that such a strategy can carry are unprecedented.

The Learning Spaces / BYOD trend constitutes by essence a kind of physical counterpart to the virtual learning environment, totally able to work in synergy with them thanks to their collaboration features. In that sense, New Generation Digital Learning Environment (NGDLE), for example, could get a significant benefice of those evolutions. Generalization of such innovative spaces, in conjunction with the BYOD, is obviously a key to their adoption, thus to their ability to really impact the teaching and learning practices, and to induce a real and measurable transformation on the campuses [15].

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