An affordance based design framework for technology-enabled learning spaces

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Educational institutions today are transforming their traditional learning spaces into technology-enabled learning spaces to facilitate innovation in pedagogy and enhance the teaching and learning experiences of its users. This transformation is driven by the changing needs of the 21st century educators and learners, and changes in pedagogical practices to meet these learning needs. The advent of digital technologies into the classroom has altered the traditional notions of teaching and learning. It has redefined the idea, design and implementation of learning activities and experiences. Learning spaces play an important role in the educational enterprise because it is the locus where educators and learners; pedagogy, content and technology; environment and experience converge. The various affordances integrated into its design play a critical role in defining the opportunities and constraints that it imposes on educators and learners using the space. However, due to the existence of diverse needs, contexts and use cases, the conceptualisation, design and implementation of such spaces vary from institution to institution. This paper discusses how the PECTS affordance framework was used to conceptualise the design of a technology-enabled learning space and how Education Design Research (EDR) was used as a developmental framework for the iterative design cycles.

Keywords learning spaces, learning space design, technology-enabled learning spaces

Introduction

The steady proliferation of technology into classroom during the last decade has made possible new ways of teaching and learning which was previously unimaginable. It has torn down barriers and empowered educators and learners worldwide and enabled them to transcend the confines of their traditional classrooms and step into a brave new world where the only encumbrance is perhaps the limits of their imagination. This unprecedented access to a wide range of technologies has obligated a dramatic reimagination of how teachers, students, content and space can interact with each other and how various affordances of technologies and space design can be taken advantage of to support teaching and learning. It has also redefined the conceptualisation, design and implementation of various learning activities and experiences that takes place in such spaces. As a result, transformation of learning spaces has increasingly become one of the key concerns of policy makers and school leaders worldwide (Bannister, 2017).

The main objectives behind the transformation of traditional learning spaces into technology-enabled learning spaces is obviously to cater to the changing needs of the 21st century educators and learners and to support the changes in the pedagogical practices in response to these changing needs. The emergence of a constructivist learning paradigm and the shift of focus from teaching to learning has rendered most of our current learning spaces ill-suited to support the needs of today's learners (Oblinger, 2006). Another important objective is to create opportunities for pedagogical innovation that leverage the affordances of space design and the technologies embedded into the space to enhance the teaching and learning experiences of its users. This focus on innovation in the design and use of learning spaces is an effort to "make a difference to pedagogical practice in the classroom" (Bannister, 2017). Oblinger (2006) has argued that innovation in learning spaces themselves can become drivers of change in pedagogical practices.

Learning space design plays a critical role in enhancing educational attainment (Leringer & Cardelino, 2011) because it "facilitates and inhibits behaviour and relationships between different actors" that use the space (Heerwagen et al., 2004; Rashid et al., 2006). Therefore, its design and the affordances integrated into its design, play a critical role in defining the opportunities and constraints that it imposes on educators and learners using the space. According to Sanoff (2001), learning spaces "mirror the ideas, values, attitudes and cultures of the people within it". They create conditions and mediate interactions that promote teaching and learning (OECD, 2017). And when we add the element of technology integration, the relationship between learning space, its users and the learning resources becomes even more complex (Goodyear, 2008). Therefore, it is important to appreciate

fully how technology is integrated and used in a learning space, how it informs its design, and how it mediates the social interactions that promote learning (OECD, 2017).

However, due to the existence of diverse needs, contexts and use cases, the conceptualisation, design and implementation of such spaces vary from institution to institution. Therefore, to embark on such an enterprise, institutions need strategies and guidelines to identify design considerations and good practices to deal with their own specific context and constraints. They need a design framework to ensure that the developmental outcome meets the institution's "educational visions and approaches to teaching and learning" and to help achieve the desired "educational transformation" (Leringer & Cardelino, 2011).

In this paper, we will discuss how the PECTS affordance framework was developed and used to conceptualise the design of a technology-enabled learning space and how Education Design Research (EDR) was used as a developmental framework to guide its iterative design cycles. It is hoped that our experiences of using these two frameworks can inform the design of similar technology-enabled learning spaces in the future.

Background

In order to meet the changing needs of 21st century learners and faculty in our institution, and to promote innovative pedagogies, the Learning Sciences and Technologies (LST) Academic Group (AG) at the National Institute of Education (NIE), Singapore embarked on the i-Space project to create a technology-enabled learning space. The AG is responsible for conducting training in ICT integration in education for pre-service student teachers, in-service teachers and higher degree learners at NIE. Prior to the development of i-Space, tutorials and workshops were held in eight Educational Computing Laboratories (ECLs) which followed the design of traditional computer labs with rows of personal computers arranged side-by-side.

Feedback from learners and faculty was that while this layout was suitable for carrying out traditional ICT lessons, the constraints imposed by design and technology called for a major rethink to meet the teaching and learning needs of a 21st century classroom (Bautista, 2013; Brown, 2006). It was also found that these ECLs were not really conducive for experimentation and implementation of innovative pedagogies supported by technology. Therefore, a team led by LST faculty and technical support members along with other relevant institutional stakeholders was constituted to conceptualize, design and implement the i-Space project.

The Design Process

The conceptualisation of i-Space began with articulation of the objectives behind the project. The key objectives identified after much deliberations were to:

- facilitate a wide range of innovative technology-enabled learning activities and experiences,
- lead and exemplify the use of technologies for innovative pedagogies to meet the learning needs of 21st century teacher educators,
- support the development of innovative mind-set and practices in teaching and learning with the support of technologies amongst faculty and students,
- promote digital literacy and nurture future-ready teacher educators, and
- translate research on various technology-enabled pedagogies into action in our various teacher education programmes.

While articulation of the objectives behind the project was the first and perhaps, the most important step towards its realization, some of the more pressing challenges that the team faced were determining its scope and scale, and deciding on framework used to guide the conceptualisation and implementation of project.

A list of affordances was populated after several rounds of consultation with the faculty, learners and other stakeholders about their specific needs and requirements. This is congruent with current and common practice of user-participation in decision-making activities (Burke & Grosvenor, 2003; Leringer & Cardelino, 2011). The goal was to promote greater sense of ownership of the learning space and user satisfaction by allowing the various stakeholders to have a say in the design process (Higgins et al., 2005). The PECTS framework was developed and then used to delineate and classify these required affordances. Various intended use case scenarios pertinent to the institution's context were also developed to further refine and update this list of required affordances.

Some of the intended use case scenarios for i-Space were for it to serve as:

- A teaching and learning space that supported the implementation of a wide range of existing technology-enabled pedagogies such as blended learning, distance learning etc.
- A space that supported ideation and experimentation of innovative technology-enabled pedagogies such as blended synchronous learning which requires live broadcast and synchronous communication and collaboration capabilities
- A digital maker space where faculty and learners could gain expertise in and co-create digital learning resources and solutions including 3D printing, chroma key technology, Audio Video editing and production, coding etc.
- A BYOD learning environment which was highly flexible and allowed multiple configurations.

This was then used to develop an initial concept of how this learning space would look like (design-wise) and what features it would have (affordance-wise). Education Design Research (EDR) methodology was adopted as a framework to guide the iterative design cycles of the i-Space project (Plomp, 2013). After each cycle, changes were made to the initial design based on feedback and new insights gained through an extensive evaluation process, which we called SELF. The SELF acronym stands for:

- Consultations with the relevant *Stakeholders* to guide the technology and design choices (faculty, admin, computer support and services, finance, estate etc.)
- Consultations with *Experts in the field (pedagogy, technology, learning space design etc.)*
- Review of *Literature* (relevant theories, research on the design of technology-enabled learning spaces and the technologies embedded in them etc.)
- *Field* visits (to review current technologies available in the market, to study the deployment of such technologies, and the design of existing technology-enabled learning spaces)

Using the SELF process, the initial concept was refined until the final design iteration stage was reached. Figure 1 depicts the adapted version of Plomp's iteration of systematic design cycles used by the team to conceive, design and implement the i-Space project (Plomp, 2013). Whenever important technology and design choices such as choice of technologies, furniture and space design had to be made during the iterative design cycles of the project, it was made with reference to this list of affordances and the intended use case scenarios.
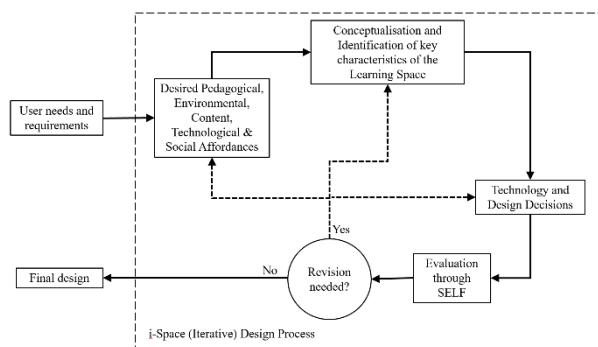

Figure 1: Adapted version of Plomp's iteration of systematic design cycles

Once the design did not need any further revision and the approvals of various institutional stakeholders were received, the final design was implemented and project realised within a year.

The PECTS Framework

Amongst the various frameworks explored were Pedagogy-Space-Technology (PST) framework by Radcliffe (2008) for designing new learning spaces and Pedagogical-Social-Technological (PST) affordance framework by Kirschner et al. (2004) for determining the utility and usability of educational systems. The OECD Learning Environments Framework which focuses on the core elements of learners, teachers, resources (i.e. space and technology) and content as well as issues of spatiality, connectivity and temporality was also among the important literature reviewed (OECD, 2017).

Radcliffe's Pedagogy-Space-Technology Framework (2008) is based on a question-driven inquiry process and focuses primarily on questions about the types of learning and teaching that the learning space aims to foster, how the design of the learning space (i.e. furniture and fittings), and integration of technology supports the types of learning and teaching envisioned. This framework is quite versatile and can be applied to a wide range of learning space projects (Radcliffe et al., 2008). The PST framework is a systemic approach towards achieving a good balance between pedagogy, space and technology by intentionally sequencing the design process and design considerations in a logical manner with recognition of the interrelationships that exists between these three elements and their influence over each other (Radcliffe et al., 2008).

In contrast, the Pedagogical-Social-Technological (PST) framework proposed by Kirschner et al. (2004) looks at learning environment and technologies as having pedagogical, social and technological components and their respective affordances. The concept of affordance, proposed by Norman (1998), refers to "the perceived and actual …properties of technologies that determine their usefulness and the ways they could possibly be used". According to Kirschner et al. (2004), the usefulness of a system can be determined by its utility and usability. While utility refers to the functionalities of a system, usability focuses on the ability of the system to support the intended tasks in an efficient and effective manner (Wang, 2008). Both utility and usefulness are critical considerations in the design of educational systems and artefacts such as learning environments (Kirschner et al., 2004; Nielsen, 1994; Wang, 2008). In educational contexts, while utility is more concerned with pedagogical and social affordances, usability is more concerned with technological affordances (Kirschner et al., 2004; Nielsen, 1994; Wang, 2008). Thus, pedagogical affordances of a learning environment refer to the teaching and learning activities that it supports; social affordances refer to the type of social interactions and presence it supports and technological affordances refer to its potential to help the users accomplish teaching and learning tasks with ease (Kirschner et al., 2004).

After studying these frameworks, a combined framework called PECTS, which synergises the important focus areas and considerations of both these frameworks and the OECD framework, was developed to help the team delineate the various affordances that we wanted this new learning space to have. PECTS stands for **P**edagogical, **E**nvironmental, **C**ontent, **T**echnological, and **S**ocial affordances. While environmental affordances consider both space and design elements of the learning environment; content affordances not only takes cognizance of content as one of the core elements of the OECD Learning Environments Framework (2017) but also as an important consideration of learner-content (resource) interactions in a learning space.

A list of affordances (Table 1) was populated after several rounds of consultation with the faculty, learners and other stakeholders about their specific needs and requirements. Various intended use case scenarios pertinent to the institution's context were also developed to further refine this list of required affordances. This was then used to develop an initial concept design of how this learning space would look like (design-wise) and what features it would have (affordance-wise).

Table 1: i-Space's PECTS affordances

Pedagogical	Environmental	Content	Technological	Social
Blended synchronous learning	Flexible	Resource creation	Intelligent recording and storage	Remote conferencing
Distance learning	Comfortable	Curation and access	Learning anytime and anywhere	Content sharing
Flipped learning	Interactive	Data collection for research	BYOD	In-class collaboration
Collaborative learning	AV Recording friendly	Analytics	Support for collaboration	Remote collaboration

Conclusion

Recent studies on learning spaces advocate the need to engage stakeholders in the conceptualization, design and implementation of learning space designs. The usage of PECTS to delineate the required affordances of the learning space in concert with a high ratio of end-user engagement and the utilization of the EDR framework to guide the iterative design cycles of the i-Space project led to its successful implementation and great end user feedback. Use of SELF, as a process, informed and refined the iterative designs of i-Space. It ensured that it met

the needs of the stakeholders, supported the pedagogical innovations envisioned, kept us updated with the various developments in the field of technology-enabled learning space design, and helped us understand the various affordances of emerging technologies and make informed decisions. The concept of learning space design is constantly evolving and becoming more complex and multi-disciplinary. As such, four most important determiners of success in the implementation of a learning space design project are i) the degree of end-user engagement to clarify the needs and requirements, ii) framework(s) used to guide the design process, iii) the breadth and depth of expertise of the project team, and iv) the rigour of the iterative design process. In terms of technology integration, while innovation is important, it must always be guided by practicality and impact on teaching and learning. What is available and good may not always be right for your institution. Therefore, ultimately learning space designs must meet the needs of its users; not the other way around.

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