Designing future hybrid creative spaces using digital tools in educational institutions and organizations

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Abstract
The existing models/frameworks that serve as reference for the design of hybrid creative space in educational institutions and organizations, have shown some limitations. On one hand, current spatial design theories concerned with hybrid spaces and digital technologies are limited; on the other hand, the analysis of digital technologies' influence on spaces conducted in Information System and Computer Science research fields rarely uses a spatial theory as a foundation. The aim of this on-going PhD research project is to develop an analytical framework that integrates creative space types and a blended space model in support of the design of future hybrid creative spaces (FHCS). The pattern language approach is applied to bring together design guidance and tools from different disciplines, in a form that can be understood and shared across disciplines. Through a pattern mining process, 323 patterns are derived from four selected disciplines. The expected outcome of this PhD project is to offer designers a useful design model (FHCS framework) and a set of design tools (design patterns) in support of the design of FHCS.

Author keywords
Design patterns; creative spaces; hybrid working; hybrid learning; blended space; spatial design.

Introduction
Conventionally, space for creative activities in educational and workplace contexts is often defined as a built formal physical environment; and these environments can also be informal spatial clusters that encourage exchanges and social networks based on in-person interactions. Users perceive and evaluate learning and working spaces through their architectural properties and physical settings (e.g., spatial layout and furnishing, lighting, colors, smells, sounds and technology, status, and image). Nevertheless, in recent years we have seen a significant shift to a more hybrid form for learning and working since the beginning of Covid-19 pandemic in 2020, and many higher educational institutions and organizations are likely to embrace "hybridity" beyond the pandemic. At the same time, "extended reality" has an emerging presence in our everyday life, and with the future of the internet and metaverse, the combination of augmented, virtual, and mixed realities will become an essential medium for social, business, learning and working engagements. Nowadays, the term hybrid space (or blended space) is widely used as an interplay of physical and digital spaces. An urgent call is raised for designers to rethink the current design practice to accommodate future challenges when designing creative spaces in transition to hybrid forms of learning and working. Therefore, this PhD project is guided by two main research questions:

1. How future hybrid spaces for creative learning and working need to be designed to support collective creativity and innovation?
2. What technologies and digital tools can be utilized for new opportunities to aid design and enable future hybrid creative spaces?

Background
"Creative space" consists of two parts - "creative" and "space". The term "creative" associates with activities related to design and innovation process. "Space" conventionally refers to the built environment in various scales, from urban context, architectural space, interior layout, to small single elements such as a furniture. The existing models/frameworks that serve as reference for the design of creative space in educational institutions and organizations, have shown some limitations. For example, most of the studies in the field of creative spaces are limited to the built environment and have not given enough attention to contemporary issues such as hybrid working and learning and emerging technologies (e.g. Wycoff and Snead, 1999; Dillon and Loi, 2006; Moultrie et al., 2007; Ceylan, Dul and Aytac, 2008; Luz, 2008; Van Meel et al., 2010; Bustamante et al., 2016; Paoli, Sauer, and Ropo, 2019; Thoring et al., 2019; Mäkelä and Leinonen, 2021; Mov-Avi, 2022). Whereas some frameworks developed design principles for creative spaces but failed to acknowledge the importance of the connections of design components in a form of network. Therefore, it is difficult for designers and users to understand upcoming design issues and set the priorities in the design process (e.g., Luz, 2008; Van Meel et al., 2010; Thoring et al., 2019). On one hand, current spatial design theories concerned with hybrid spaces and digital technologies are limited; and on the other hand, the analysis of digital technologies' influence on spaces conducted in Information System and Computer Science research fields rarely uses a spatial theory as a foundation (Mütterlein and Fuchs, 2019).

Creative Space Types	Physical Space summerized by Thoring et al. (2018)	Digital Space summerized by author
Personal space	allows for concentrated 'heads-down' work (thinking, reading, writing), deep work, and reflection; requires reduced stimulation to avoid distraction	access to single-user digital space, storage and resources; applications to support; allow control of personal territories; easy transitions between personal devices and shared devices.
Collaboration space	is used for group work, workshops, face-to-face discussions, client meetings, or student– teacher consultations.	access to multi-user space and digital storage; share and display knowledge; provide a clear structure for access to collaborative functionality and media content; provide alert to indicate changes; application support synchronization across digital spaces; provide meeting area
Presentation space	is used to share, present, and consume knowledge, ideas, and work results in a one-directional way (presentations or exhibitions)	provide a platform for display of work and social interaction; knowledge transfer; highlight presenter or work; encourage feedback; Provide software to support multi-user interaction; control interfaces and activities; easy transitions between personal devices and shared devices.
Making space	is used for model making and building; allows experimentation, play, noise, and dirt.	Access to user space, storage and resources; provide simulation of physical tools and training; provide software to support multi-user interaction and shared digital areas; access to software and training materials; application support synchronization across digital spaces
Intermission space	connects other space types; is used for breaks, recreation, and transfers; includes hallways, stairs, cafeterias, and outdoor areas	provide reflection and relax space; disengage and play; simulation of nature or outdoor space; navigation portals; facilitate knowledge transfer; facilitate casual exchanges; enable collective breaks; provide recreation and gaming zone; provide overview of the space for easy navigation between digital spaces

Figure 1. Key design issues suggested for both physical and digital spaces.

Theoretical framework

In a built environment, Thoring et al. (2018) identify five space types associated with creative processes in the literature and empirical evidence. They are personal space, collaborative space, making space, presentation space, and intermission space. For designers to develop hybrid space, Figure 1 *presents key issues that are suggested in digital spaces as well as physical ones*. Moreover, to adopt existing spatial design knowledge and theory in the context of hybrid spaces, architects and interior designers need a new model bridging the physical and digital environments, as well new useful design tools derived from other disciplines.

An analytical framework for future hybrid creative spaces: FHCS framework

Following Lefebvre's theory (1992) and Milgram and Kishino's Virtuality Continuum (1994), a hybrid creative space brings together at least two distinct modes to create a new spatial typology, where a physical space flowing within a digital space and vice versa seamlessly becomes possible with technologies. Built on Blended Space model (Benyon & Mival, 2015), the author develops an analytical framework for designing future hybrid creative spaces. Figure 2. *illustrates the relations between four space domains in FHCS framework*. For the physical space, the author only focuses on five types of creative spaces mentioned in Figure 1. The digital space consists of more diverse forms, such as applications, data, actions and events. In the generic space where characteristics are shared by both physical and digital spaces, four attributes (ontology, topology, volatility, and agency) (Benyon, 2012) should be considered. In the hybrid/blended space, five hybrid design themes (territoriality, awareness, control, interaction and transitions) seem to be a relevant starting point for the development of a new spatial typology of FHCS. The author also intends to indicate that hybrid creative spaces can be designed with a new collection of design tools potentially derived from both physical and digital domains. Figure 3. *presents a new spatial typology defined by two sets parameters, creative space types and hybrid design themes*.

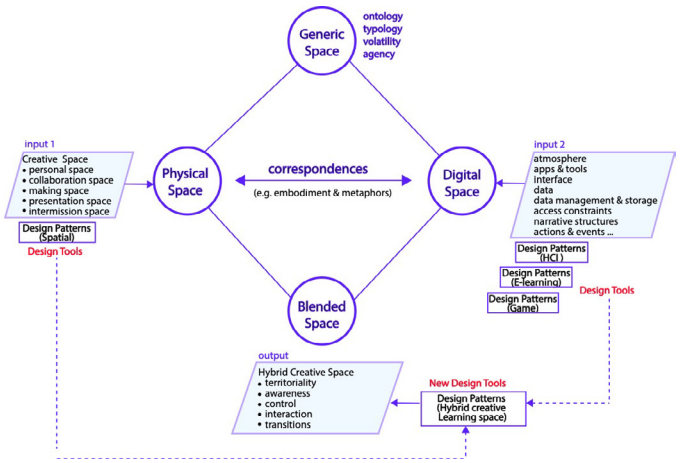

Figure 2. FHCS Framework, adopted from Benyon & Mival's Blended space model (2015) (Drawn by author).

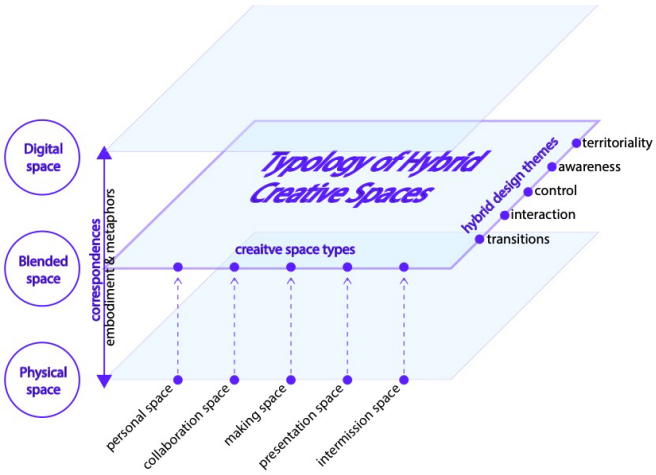

Figure 3. FHCS Typology is defined by two sets parameters, creative space types and hybrid design themes (Drawn by author).

Research approach and method

The aim of the present research is to develop an analytical framework that integrates creative space types and blended space models (FHCS framework), in support of the design of FHCS. The review of the literature has shown that many different social-spatial design solutions exist for both physical and digital spaces, and they have been systematically organized in a form of pattern language. Identified pattern candidates are from various specific application domain, and they

Table 2. Overview of 17 design requirements for FHCS (Drawn by author).

ID #	Design requirement
R1	Space as a platform or network for ideas
R2	Social interaction, micro multination
R3	Human-centric, culture, and identity
R4	Biophilic design
R5	Playful experimental atmosphere
R6	Software and hardware support
R7	Flexible space, changeability
R8	Ownership of space
R9	Multi-sensory stimuli (visual, tactile, olfactory and acoustic)
R10	Accessibility
R11	Integrating technology &Infrastructure
R12	Space and information management
R13	Reduced stimulation, back to analogue
R14	Bodily awareness and movement
R15	Techiture
R16	Making spaces
R17	Creative labelling

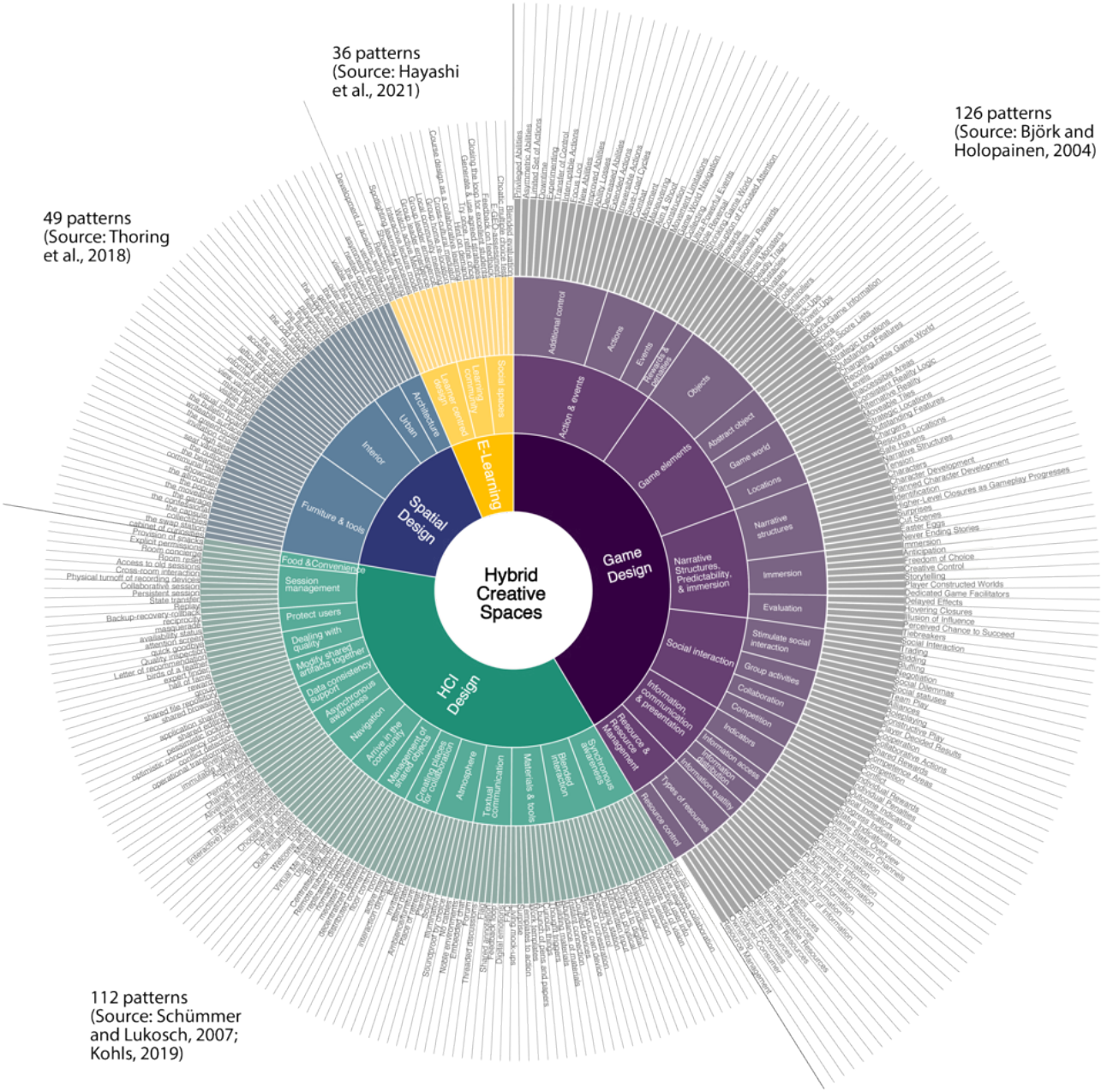

Figure 4. 323 pattern candidates from four disciplines (Drawn by author).

capture and represent design knowledge of the experts. Therefore, the pattern language from Christopher Alexander et al. (1977) seems an appropriate approach to bring together design guidance and tools from different disciplines, in a form that can be understood and shared across disciplines. Moreover, it can offer a connected network of design patterns that continues to grow and evolve through the knowledge and experience input from the experts. This research is conducted in three main steps:

1. Pattern mining. A mix of methods is used to derive pattern candidates from existing pattern frameworks of various disciplines, organizations' reports, case examples and expert interviews.
2. Pattern analysis. Collected pattern candidates are verified by a multi-case study and focus groups. Network analysis is subsequently employed to identify the network structure of patterns visually and statistically.
3. Pattern writing. This process involves proper naming and writing of patterns in a standard template with detailed description. This is realized through a workshop with pattern experts.

Design requirements for future hybrid creative spaces

To better understand how to create successful hybrid creative environments, the author investigates the potential challenges and opportunities of using and designing hybrid spaces, especially related to creative process. Insights are gathered from recent literature, organization reports, expert interviews, and real-world cases. Table 1 *summarizes important design requirements for FHCS*.

Results and discussion

Through the pattern mining process, various pattern frameworks and many pattern candidates have emerged from the analysis. Given their relative importance and time restrictions, the author puts an emphasis on the patterns that fit the following criteria: (1) Relevant to hybrid social-spatial de-

sign; (2) Addressing to the design requirements of FHCS; (3) Supported by empirical evidence; (4) Completeness of the pattern language, including pattern descriptions, hierarchies of the patterns, and indication of the internal links among patterns.

As a result, *323 patterns are derived from four disciplines, Spatial Design (49 patterns), HCI design (112 patterns), E-learning (36 patterns), and Game Design (126 patterns), and they are organized in their original clusters and sub-clusters* (Figure 4). After further analysis of these patterns' possible application, *13 generic pattern clusters have evolved, which are mapped in relation to hybrid design themes* (Figure 5).

Conclusion and future work

This PhD research project addresses the design issues from both physical and digital spaces in support of the design of FHCS, as well as to use a pattern language approach to bring together useful design guidance and tools from different disciplines. Moreover, this project will also offer a systemic network that continues to extend and evolve with the input of knowledge and experiences from experts. Based on current findings, the pattern candidates (or proto patterns) collected from four disciplines have proven validity in their original contexts, and together they offer a huge potential for solving problems that might not so easily be solvable alone, as interdisciplinary work with patterns is endorsed by many architects and pattern language theorists (Alexander, 2002-2005; Salingaros, 2005; Leitner, 2007; Neis, 2015). However, the proto patterns have to be transformed or updated for hybrid creative spaces, based on the FHCS framework. Future work will include the evaluation and validation of the patterns, plus analysis of their connections. The following actions are currently planned:

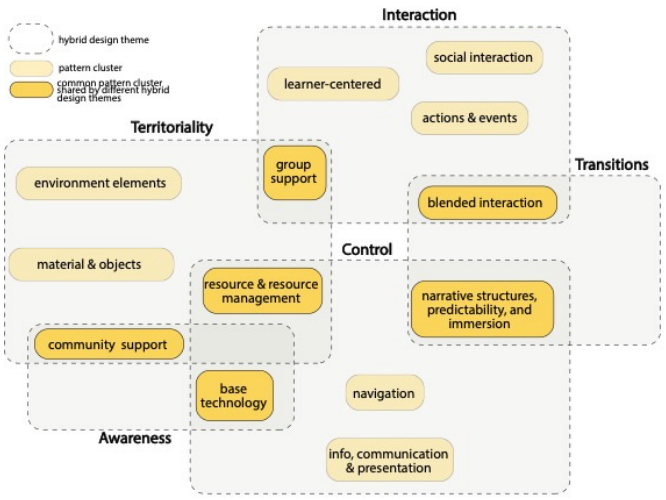

Figure 5. Five hybrid design themes and how they are addressed by 13 generic pattern clusters proposed in this study (Drawn by author).

- Development of a spatial typology for hybrid creative environments and its implementation into the blended space framework.
- Multi-case study in three design institutions (UK and Belgium), including interviews and observations of their creative learning spaces.
- Network analysis on proto patterns to identify their new links, and evaluation of the links with focus group.
- Pattern writing workshop (focus group workshop) with experts.

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