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DOI
10.1016/j.destud.2018.02.001

Publication date
2018

Document Version
Accepted author manuscript

Published in
Design Studies

Citation (APA)
Thoring, K., Desmet, P., & Badke-Schaub, P. (2018). Creative environments for design education and practice: A typology of creative spaces. *Design Studies*, *56*, 54-83. https://doi.org/10.1016/j.destud.2018.02.001

Creative environments for design education and practice: A typology of creative spaces

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Abstract

This article presents a typology of creative spaces that is relevant to facilitating creative working and learning processes for designers. Drawing on qualitative user research with cultural probes in a design thinking institution, this typology identifies five different types of creative spaces along with five related spatial qualities. The paper suggests characteristics and criteria for each type and quality and summarizes the results in a framework. A second study in a practitioner's context validated these findings. The work presented in this article contributes to a better understanding of the impact of the built environment for creative design in education and practice and might inspire designers and educators to improve the design of their work environments.

Keywords:
– architectural design
– interior design
– system(s) design
– design thinking
– creative space

Designing and learning are two sides of the same coin. As design practitioners, we constantly have to adapt to new situations and contexts. No design project is the same, and research is part of almost any design project. At the same time, today's design education is mainly centred on project work, sometimes involving real clients. Consequently, design educational environments are considered to have similar requirements as spaces in design practice. Analysing creative spaces in both design education and design practice might reveal interesting insights for both worlds. The goal of this study is to provide an overview of relevant space types for creative work along with related spatial qualities that forms a typology of creative spaces relevant for design education, design thinking, and design practice.

This article is structured as follows: In the first section, we review the relevant literature. Section 2 presents our research method. Section 3 describes an empirical study in an educational institution for design thinking. The findings from this study have led to the development of the typology of creative spaces. Exemplary spaces from the study are shown to illustrate possible applications of different space types and qualities. In Section 4, we present an additional study in a practitioner's context to validate the typology. We conclude by discussing our findings and providing suggestions for future work.

1. Literature Review

Recently, public interest in creative environments has increased, which can be reasoned from the large number of 'coffee table books' on the topic of creative office spaces (e.g. Borges, Ehmann, & Klanten, 2013; Georgi & McNamara, 2016; Groves, Knight, & Denison, 2010; Stewart, 2004) and books about creative learning spaces (e.g. Dudek, 2012; Ehmann, Borges, & Klanten, 2012; Mirchandani, 2015). However, these publications merely present a collection of photographic case examples of peculiar office or learning spaces. They are rarely categorized systematically; neither do they provide any theoretical underpinning about possible reasons why the spaces are designed as they are. Nevertheless, these examples demonstrate an increased public and corporate interest in the topic of creative working and learning environments that warrants further investigation. What follows is a structured literature review on the phenomenon of creative work environments in design thinking, design practice, and design educational contexts to provide an overview of relevant literature in this field.

1.1 Procedure

We conducted a keyword search within the Scopus database with a focus on 'creative *learning* spaces', and a second search with a focus on 'creative *work* or *office* spaces'. For both search steps, possible combinations with synonyms were also considered (e.g. space vs. environment, creative vs. innovative, office vs. work). The results were limited to peer-reviewed journal and conference publications only.[1]

We analysed the returned 242 sources based on their abstract. We identified papers for exclusion that were either unrelated to the topic or limited to specific aspects of the creative environment (e.g. lighting, climate, ergonomics of office chairs) as well as papers that addressed a peculiar (non-design-related) context, such as hospitals, libraries, or nursing homes. We conducted a full-text analysis on the remaining 43 sources, which left us with 30 sources. After a backward and forward citation analysis, we identified 14 more sources as potentially relevant for the topic. In this step we also included non-peer-reviewed sources such as books and PhD theses that appeared to be of relevance. This procedure resulted in a total number of 44 sources that were included for further analysis. From these 44 sources 15 presented classification systems, such as the one we suggest in this paper. The remaining 29 sources represented either literature reviews about the phenomenon, case studies or empirical studies, experimental approaches, theories about the influence of space on creativity, or guidelines for designing creative spaces. Several sources presented combinations of various approaches. We limit our discussion below to the 15 classifications because this is also the concern of our work. The remaining 29 sources will be discussed in future work. Figure 1 illustrates the systematic literature search approach.

[1] A preliminary version of the 'typology of creative spaces' was previously published under the title 'Creative space in design education: A typology of spatial functions' (Thoring, Luippold, & Mueller, 2012). This paper was not included in our discussion of the related literature.

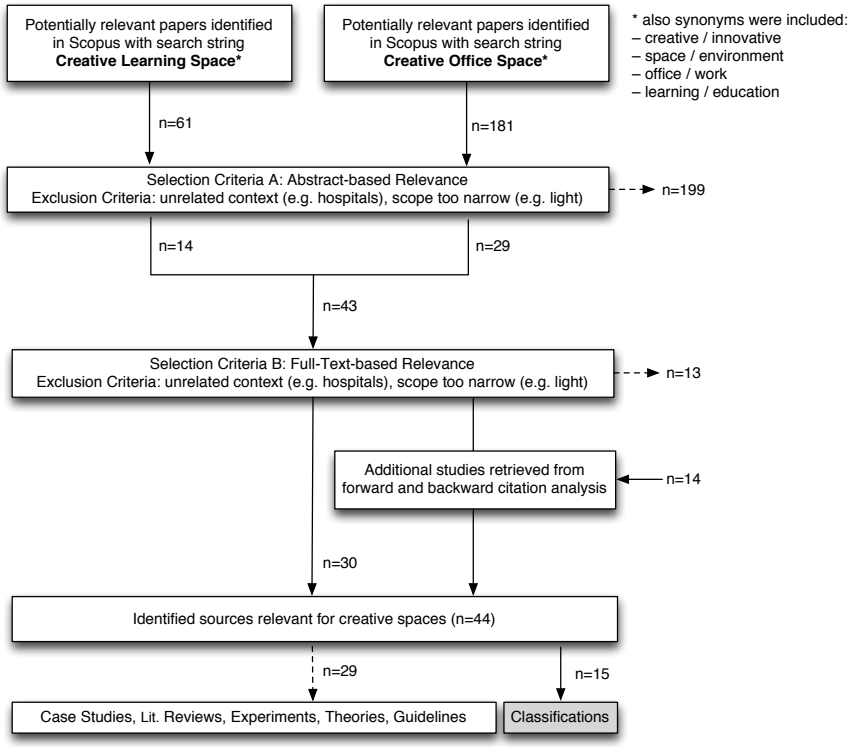

Figure 1. Schematic overview of the systematic literature search process.

1.2 Results

The included 15 sources that presented some sort of framework, typology, or classification of creative spaces are discussed in the following section.

Five of the analysed sources referred to educational environments: Setola and Leurs (2014) presented a framework for creative learning spaces, which they label the Wild, the Pub, the Attic, and the Workplace. This metaphor maps onto Kolb's (1984) learning cycle. 'The Wild' suggests the activity of observation; 'the Pub' is identified as a space for sharing thoughts with others; 'the Attic' should be used for analysis; and 'the Workplace' is for planning and making things. Jankowska and Atlay (2008) presented a framework in which they distinguish three types of learning spaces: S-space (social learning space), F-space (formal space), and C-space (creative space). They found that C-spaces enhance creativity with visual and aesthetic qualities, writable walls, flexible layout, and special technologies. Leurs, Schelling, and Mulder (2013) studied multimedia design students and the ways in which studio space and ownership of the environment can enhance the learning experience. They distinguish between space (three-dimensional surroundings) and place (space with meaning, value, and functions that foster commitments and team spirit). They suggest a three-stage process: 1) make space, in which students are provided with space, supplies, and tools; 2) make place, wherein students establish ownership—that is, students make the space their

own; and 3) make sense, in which meaning-making occurs—i.e. students identify patterns and connections among research data, insights, sketches, and ideas. Lawson and Dorst (2009) identified four types of spaces relevant for design education: the studio that imitates design practice and in which students work on given design projects; the tutoring space, in which tutors guide, consult, and teach the students; the crit room, in which internal and external experts or fellow students are invited to review and give feedback on the students' designs; and the design library as both a study room and a repository of design literature and precedents. However, they did not elaborate on the physical characteristics of these spaces.

Doorley & Witthoft (2012) presented a classification of spaces inspired by the school of design thinking in Stanford/USA. They suggested four categories: places (home base, gathering space, threshold/transitions, support structure), properties (posture, orientation, surface, ambience, density, storage), actions (saturate, synthesize, focus, flare, realize, reflect), and attitudes (collaborate across boundaries, show don't tell, bias toward action, focus on human values, be mindful of process, prototype toward a solution). However, the relations between those categories remain unclear. Moreover, some categories appear to be redundant (e.g. storage and support structures), and others appear to be rather unrelated to the spatial configuration (e.g. actions and attitudes).

From the 15 classifications, 9 addressed creative spaces within design practice or creative office environments in general. Moultrie et al. (2007) proposed a framework to better understand the design, role, and goals of creative spaces in a practitioner's context. They distinguished between strategic intent, process of creation, process of use, and physical embodiment of intent. From these categories, only the physical embodiment relates to our concept of physical creative space. The authors presented 10 categories within this concept: geographic location, scale, real/virtual, flexibility, design values and imagery, IT resources, data and information, modelling and visualization resources, constraints, and evolution. These categories are not further detailed or illustrated through examples. Williams (2013) presented a typology of creative workplaces, based on the metaphor of linguistics' grammar. In a semiotic sentence structure, the condition of a specific intended behaviour (syntax) would result in a peculiar combination of place, properties, and affordances (lexis). She distinguished between behaviours (engage or disengage with people or ideas), place (official workspace, semi-official workspace, informal workspace, informal spaces at work, plus five non-workspaces, such as home or transportation), properties (comfort, sight, sound, spaciousness, movement and aliveness), and affordances (tools and equipment). Dul & Ceylan (2011) presented a framework consisting of 9 social-organizational and 12 physical

work environment characteristics that were supposed to influence employee creativity. The 12 physical characteristics are: furniture, indoor plants, calming colours, inspiring colours, privacy, window views (nature), any window view, quantity of light, daylight, indoor climate, sound, and smell. Besides these characteristics no space types or qualities were identified. Greene and Myerson (2011) provided a classification of different types of knowledge workers that might lead to different requirements for creative spaces. They identified the anchor, the connector, the gatherer, and the navigator, and presented spatial requirements for each. Martens (2008) presented a hypothetical framework outlining the contribution of the physical work environment for creativity and creative work processes, based on a case study. The framework positions creativity, creative work, and an appropriate work environment. Critical factors identified were layout, furniture, colour, finishing, and light. Based on a literature review of 17 articles, Meinel, Maier, Wagner, and Voigt (2017) identified several categories of interest regarding creativity-supporting physical work environments: They defined five aspects regarding spatial layout (privacy, flexibility, office layout, office size, complexity), four space types (relaxing space, disengaged space, doodle space, unusual/fun space), and several tangible office elements (furniture, plants, equipment, window/view, decorative elements, materials) and intangible office elements (sound, colours, light, temperature, smell). They summarized the results in a framework. Lindahl (2004) investigated the influence of the workplace on organizational performance but without a specific focus on creativity. Based on several case studies, he identified four relevant spatial aspects: work environment qualities (health and safety), metaphorical and symbolic qualities (corporate image and identity), spatial configuration (dependencies between activities and spatial setting), and the quality and degree of participation in the design process. He summarized the results in a set of models. Van Meel, Mertens, and van Ree (2010) provided a set of abstract principles and design considerations for office design (e.g. the work lounge, the locker area) and presented examples for each. However, these classifications resemble a list of resources for architects and office planners rather than a systematic framework of creative spaces. Groves-Knight and Marlow (2016) presented a rudimentary framework of ‘innovation spaces’ arranged around 10 themes, which are supplemented by expert interviews and exemplary cases. The focus was on corporate environments; as a result, learning environments were rarely addressed. The suggested themes also remain rather indistinct and unstructured. Most themes address factors that might influence the process of designing creative spaces rather than a spatial classification itself, for example the available “resources”

or the “invitation” that suggests to involve all stakeholders in the design process. The framework does not distinguish between actual types or qualities of the physical spaces.

The only source that addressed creative spaces in both design education and practice is from Walter (2012). Based on existing literature, he suggested a conceptual framework for creating a workspace that increases creativity in both learning and office environments. It aligns the physical features of the workplace with the creative process but without distinguishing this process into certain activities or space types. Additional concepts are the organizational climate for creativity and conceptual features of the workplace, such as flexibility, ubiquity, variety, interaction, and access to resources. The framework remains vague due to the lack of examples or empirical evidence.

1.3 Summary

While diverse in aims and methods, the analysed studies support the proposition that the quality of creative work and learning is influenced by the design of the interior and exterior space in which the design activities take place. However, the literature revealed that there is currently no satisfactory and comprehensive typology of creative spaces for design education and practice. Many studies do not provide examples and hence remain vague. Only one typology addresses both design education and practice; most sources focus on only one area. Moreover, some sources do not focus on creative or design contexts, which weakens their attempt to define *creative* spaces. The discussed sources all make use of their own terminology and structure, which makes it difficult for the researcher and practitioner to compare and integrate the existing knowledge. Also, most of the presented typologies were not validated through additional studies. Although the studies do address some relevant space types and qualities on various levels, altogether the impression emerges that none of them is comprehensive.

These results warrant our attempt to systematically develop a typology of creative spaces that is (a) comprehensive, (b) addressing design education and practice, (c) based on empirical data, (d) provides tangible examples of spaces, and (e) is validated through an additional study. In the following sections, we outline the development of our typology of creative spaces. In Section 5.2 we refer to the literature again to highlight differences and similarities between our typology and the analysed sources.

2. Methodology

The goal of this study is to identify different types and qualities of spaces within the analysed institution, and to understand how these spaces were used by the participants by analysing their behaviour and collecting their ideas and visions for creative spaces. For this purpose, we conducted a qualitative study following a grounded theory approach (Glaser & Strauss, 1967), using cultural probes (Gaver, Dunne, & Pacenti, 1999; Mattelmäki, 2006). We chose this qualitative approach to analyse the system of creative spaces in a realistic context. We use the space in an educational design thinking institution—the Hasso Plattner Institute's School of Design Thinking (HPI D-School) in Potsdam, Germany—as the basis for our first case study for the following reasons:

(1) We expect a school for design thinking to provide a broader and more comprehensive design education than a traditional design school because it focuses on creativity and innovation from several disciplines while still integrating classical design skills, such as sketching and model making.
(2) Design thinking addresses design as a problem-solving technique beyond mere form giving, which reflects a more contemporary idea of design (Dorst, 2011).
(3) Design thinking can be located in the intersection of educational and practice contexts. Education here is mainly based on real client projects, but it still requires lecturing and teacher feedback.

Hence, we expect the study's findings to cover a broad range of possible applications that might be transferable to both design education and design practice as well as other contexts.

2.1 Context Description

The HPI D-School is an educational institution for interdisciplinary design thinking. There are approximately 120 design students studying at a given time. The study programme is part-time—two days per week—and is divided into two tracks—one basic track (first semester) and one advanced track (second semester). The programme lasts two semesters in total and is targeted at students from all disciplines as a part-time extramural study. Basic-track and advanced-track students are accommodated in two separate buildings. The two buildings were built just a few years ago. The interiors were designed specifically for the requirements of design thinking education, focusing on working in small teams rather than in traditional classroom or office settings.

2.2 Cultural Probes

Cultural probes are a method for qualitative user research (Gaver et al., 1999; Mattelmäki, 2006) that provide participants with a set of tools, typically consisting of single-use cameras, user diaries, maps, postcards, or the like—along with instructions on how to complete the tasks. The participants work independently on these tasks for a specified amount of time. The advantage of this method is that the participants may document and comment their existing environments and provide their wishes, critique, and visions about the spaces as well. The cultural probes boxes we prepared for the participants in this study contained several items they were encouraged to use to document and evaluate their study and work environments, such as a diary with certain questions and several floor plans to indicate positive and negative spaces. See Figure 2 for an overview of the cultural probes.

Figure 2. The set of cultural probes that were handed to the participants included several floor plans, a single-use camera, a diary with prompts, and additional tools to document and evaluate their creative environments.

2.3 Procedure

We recruited a total of 9 participants and handed each of them a set of identical cultural probes to complete within two weeks time. The participants were chosen to represent a broad range of different students with diverse backgrounds. We included only students from the advanced track, because they would be familiar with both buildings.

2.4 Returned Data

The study yielded a significant amount of rich data (sketches, pictures, notes). Each of the approximately 200 photos we received included a written description of why the depicted

space was evaluated as positive or negative and in what way the spaces were able to support or hinder the respondent's creative work process. Each photo was marked on one of the provided maps of the university's buildings or campus with a red or green sticker to indicate a negative or positive aspect, respectively. The diaries and postcards revealed insights about participants' wishes and needs and their insights about missing spaces within the institution's environments. After an initial data analysis, we invited each participant for an individual follow-up interview to answer emerging questions and to clarify reasons why respondents had marked certain spaces as positive or negative. Then, the resulting data were analysed using a grounded theory approach with open and axial coding (Corbin & Strauss, 2014).

Figure 3 shows an overlay of the campus map from all participants, which allowed us to identify areas with frequent indications of positive or negative spatial aspects. Each icon on the map represents a photograph taken by a participant. Red indicates a negative impression; green, a positive one. Each picture was described in more detail with handwritten notes. Selected photos taken by the participants are presented in Section 3.

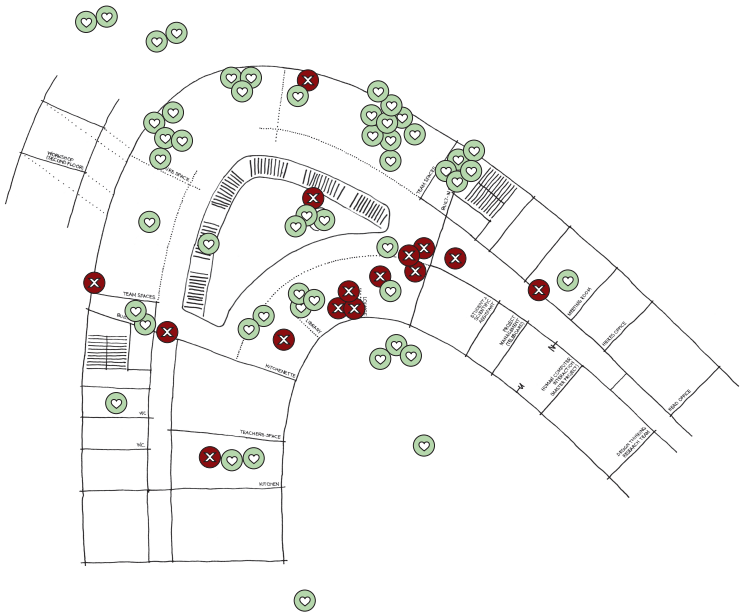

Figure 3. Indication of positive (light green dots) and negative (dark red dots) aspects on provided campus map, aggregated from all participants; each dot represents a photo.

Figure 4 and Figure 5 show exemplary results from the diaries and postcards. Here, the students were able to express their wishes, needs, and visions regarding their institutions' creative environments. Using these, we were able to identify the types and qualities of existing spaces on the campus as well as those that might be missing.

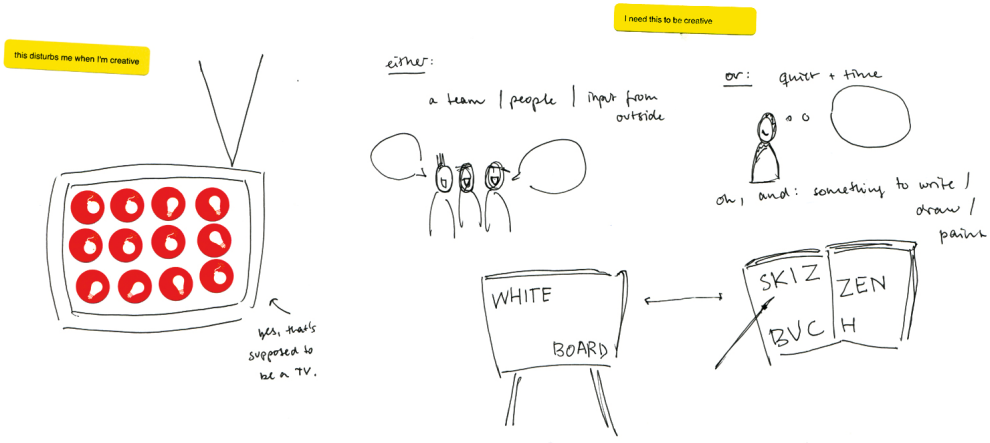

Figure 4. Selected pages from the diary of one participant: responses to the pre-printed prompts, 'this disturbs me when I'm creative' (left), and 'I need this to be creative' (right).

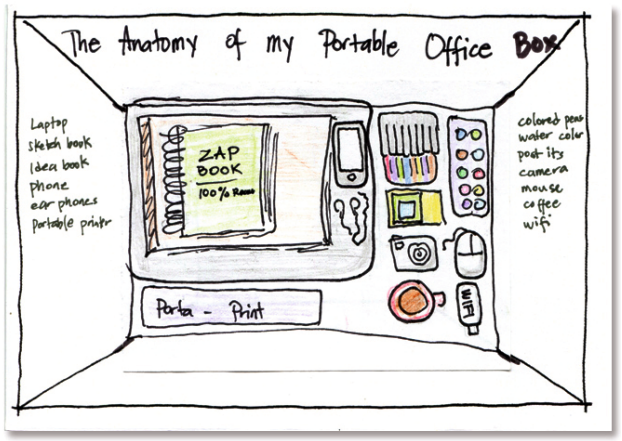

Figure 5. Exemplary postcard ('My perfect workplace').

2.5 Data Analysis

The data analysis was conducted by three researchers using an open and axial coding approach (Corbin & Strauss, 2014). Together, they read all the written notes and examined all the sketches and other visual material provided by the participants. After conducting follow-up interviews to clarify emerging questions, the researchers transcribed the main insights from each item (photo, sketch, or note) as well as the insights from the interviews onto colour-coded Post-It notes. These notes were tagged with (+) or (–) symbols to indicate positive or negative comments about the given space. Subsequently, the researchers clustered the Post-It notes according to the similarity of the material. Data, codes, and clusters were compared constantly with each other and merged, split, named, and renamed as necessary. This procedure was repeated until no further categories emerged—that is, to the point of theoretical saturation (Corbin & Strauss, 2014). Through this procedure it was also possible

to identify relationships and influences between categories (axial coding). We were able to classify different types and qualities of creative spaces by extracting insights from the participants' documentation of existing spaces, as well as from the diaries and postcards that revealed the spatial needs that were not met by the existing spaces. In this way, it was possible to identify additional space types and spatial qualities, even if they were not currently present in the environment of the analysed institution. The process resulted in 10 identified clusters: five 'types' and five 'qualities' of creative spaces. The typology developed based on these findings is described in the next section.

3. Typology of Creative Spaces

3.1 Definitions and Overview

A 'space type' is a dedicated space for a specific activity at a specific time (e.g. presentation, teamwork, model-making). Each space has an inherent 'affordance' (Norman, 1999, 2002) that suggests the kind of activity for which the space is mainly intended, which is enforced through its configuration (e.g. the room layout and furniture). This configuration can be changed, which means that a space type can also change. However, changing a space type requires some time and effort, whether it be moving chairs or breaking down walls. The degree of time and effort required to change a space from one type to another determines its degree of flexibility.

We distinguish between five different types of creative spaces: (1) the personal space, for working or learning alone; (2) the collaboration space, for working or learning together with co-workers, classmates or teachers; (3) the presentation space, for giving presentations, consuming lectures, and displaying or examining creative work examples; and (4) the making space, in which people are able to experiment, try things out, build stuff, and make noise. A fifth category emerged from the data: intermission space for transition and recreation (5). This category includes spaces that are not deliberately intended for creative design work but connect the other space types—for example, hallways, cafeterias, or the outdoors—and provide spaces for breaks. These five space types covered all the existing spaces within the analysed institution.

Orthogonal to the space type, we identified another category: the 'space quality'. This is a space's capacity to facilitate a specific purpose, independent from the space type. We distinguish between five different qualities of a creative space: a given space can be (a) a knowledge processor; (b) it can be an indicator of organizational culture; (c) it can act as a

process enabler by providing an appropriate infrastructure; (d) it can have a social dimension; or (e) it can be a source of stimulation. The quality can have a positive or negative effect on the work process, depending on the respective process phase, the extent and characteristic of the quality, or individual preferences. Figure 6 illustrates the space types and qualities. Each space type and spatial quality is described below in detail and illustrated through examples from the analysed institution.

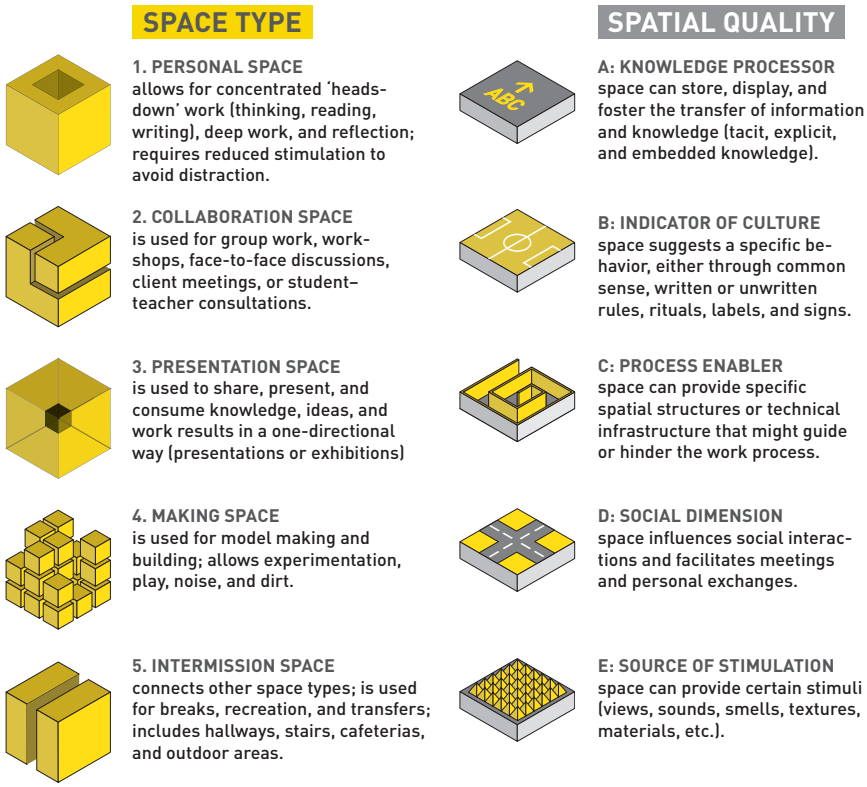

Figure 6. Overview of types and qualities of creative spaces

3.2 Space Types

3.2.1 Personal space. Just like a monastery, the personal space allows for concentrated working (thinking, reflection, meditation) and is usually characterized by a silent atmosphere and a lack of distractions. Newport (2016) coined the term ‘deep work’ for this kind of working style. People use these spaces for personal ‘alone time’ and for intense work activities like research, reading, writing, CAD work, or individual ideation.

The students of the HPI D-School used so-called ‘spy-spots’ for personal withdrawal—secluded areas of approximately 5 m^2, built at a slight elevation above the normal workspace, which allow for observation of the entire floor. These spaces were purposefully designed to provide opportunities for personal withdrawal (Figure 7). Besides

that, there were few venues for individual work. Many students mentioned outside areas like a tree bench or a commuter-train ride for this purpose.

Figure 7. Personal spaces at HPI D-School: Outdoor tree bench; 'spy-spot'.

However, at the HPI D-School, such possibilities for individual work were limited. Many students mentioned their preference for working at home owing to the lack of spaces for personal withdrawal and concentrated work. The lack of such individual workstations is evident, attributable to the programme's reliance on a collaborative group work model; even so, the participants in the study emphasized that spaces for individual work and personal withdrawal were missing.

3.2.2 Collaboration space. This is a creative space type that invites people to work together as a team, exchange ideas, and communicate with each other. It is characterized by noise, playfulness, and team interactions. The layout of the room should allow for group work and discussions. Consultation space—where students and teachers meet for feedback—and meeting space with clients also fall into this category.

Figure 8 shows selected collaboration spaces at HPI D-School. Typical of design thinking facilities, we see separated work booths with moveable whiteboards and stools instead of normal tables and chairs. Up to eight such team spaces are located on the main teaching floors. Outside areas are integrated into the workflow: if the weather permits, students can occupy one of several outdoor booths that are equipped similarly to the indoor team spaces.

Figure 8. Collaboration spaces at HPI D-School: Team booths; outdoor pavilions.

3.2.3 Making space. This is a term for a creative space that allows people to experiment, try things out, and build stuff. These spaces allow for experimentation, noise, and dirt.

HPI D-School integrates its making spaces into the main teaching areas. A workbench with tools is located in one corner of the main teaching floor. Prototyping materials are on hand in shelves and transparent boxes (Figure 9).

Figure 9. Workbench and material storage in the main lecture area of HPI D-School

3.2.4 Presentation space. Presentation space is a term for a creative space where people passively consume input (such as lectures) or actively give input themselves (such as presentations). Usually the layout of such lecture rooms does not facilitate (active) teamwork, but it does provide for giving and receiving feedback. This type of space also includes passive display of work results and exhibitions (e.g. models in showcases or posters on walls).

At HPI D-School, the lecture space in the basic track building is furnished with moveable sofas on wheels, stacking chairs, and additional seating cubes that can be arranged according to the size of the audience. In the advanced track building, theatre-style platforms with cushions are installed in the room, which did not allow much of a flexible arrangement. Additional sofas, mainly for guests or speakers, provided some variety. Prototypes from previous projects were displayed in shelves and boards on the walls were provided for occasional ‘project exhibitions’ (see Figure 10).

Figure 10. Various lecture spaces and the display of project results on walls at HPI D-School.

3.2.5 Intermission space. There were some spaces that could not be classified as one of the four abovementioned space types. Hallways, outdoor spaces like parks or parking lots, the Mensa and students' café, or pathways were obviously not dedicated areas for creative work; but people nonetheless integrated such spaces into their creative workflow. Such 'intermission spaces' were particularly characterised by unintended meetings, chance encounters, and opportunities to take a short break and reflect on previous work. In addition, research activities extend the range of creative spaces to areas beyond the building itself.

At HPI D-School, the main intermission spaces were the pathways between buildings for the two study tracks, which were about a 10-minute walk. These distances were mentioned negatively, because they impeded exchange between basic and advanced students. Most students commuted to the institution by rail; the train was mentioned as a space for thinking, meeting classmates, and doing research. Staircases within the building or the elevator were indicated as meeting spots, whereas outdoor areas, such as parking lots and a bench, were used for recreation and smoking breaks (Figure 11).

Figure 11. Intermission spaces at HPI D-School used for casual meetings and reflection: Staircase; pathway to parking lot; entrance area.

3.3 Spatial Qualities

3.3.1 Space as a knowledge processor. One interesting aspect of a space is its capacity to serve as a knowledge facilitator or repository. Information can be stored on shelves (in the form of books, materials, notes, pictures, and so on), or on the walls (e.g. sticky notes on whiteboards). Physical models or other work results (e.g. posters) from previous projects or more advanced students incorporate knowledge, which can be extracted or used as a source of inspiration. Knowledge might be represented visually, so that other people can access it easily. In that way, the space can foster the exchange or even generation of knowledge by providing the platform for displaying and accessing it.

At HPI D-School, there were several types of libraries incorporated into the teaching spaces: a small book library, a materials library, and a gadget library. Writeable walls and whiteboards could be used to store notes, pictures, and sketches to be accessed by other

students. A bulletin board with pictures and skills of coaches gives hints about who is available to help with specific tasks (Figure 12).

Figure 12. Knowledge repositories at HPI D-School: Bulletin board with teachers' expertise; whiteboards and writeable walls; bookshelves with a small library.

3.3.2 Space as an indicator of culture. A space can serve as an indicator of a specific (corporate or organizational) culture. Many spaces express expectations for how the user should behave, either embedded in the layout or just by common sense (e.g. everyone knows that you have to be quiet in a library or that you are allowed to make noise in a workshop). Written rules within a space can also serve this purpose. It is important to establish a specific culture to avoid misuse or to foster a supportive atmosphere for creative working and learning purposes. In that sense, spatial culture can support the 'affordance' of a space—its ability to indicate how it is supposed to be used or how one should behave in it (Norman, 1999).

At HPI D-School the expressed culture was very playful, with lots of toys on hand. Written rules addressed the design process itself ('brainstorming rules'; see Figure 13).

Figure 13. Culture at HPI D-School: Toys, table soccer, and other games on hand indicate a playful culture; written brainstorming rules; a 'VIP' sofa for guest critics.

3.3.3 Space as a process enabler. The space can also enforce or even dictate specific procedural behaviours, mainly based on the provided infrastructure. For example, tables and chairs affixed to the floor in a lecture hall do not allow group work. In that sense, the process enabler is an extension of the 'affordance' concept—the space dictates a specific usage or behaviour, rather than suggests it. The flexibility of a space or its furniture is important in

allowing for different creative activities. A space's capacity to change from one type to another with minimal time and effort determines its flexibility. Moreover, for a smooth workflow it is helpful if the different types of spaces are aligned next to each other or within short walking distance (reduced transition spaces).

At HPI D-School, rolling furniture and foldable walls allow for a flexible teaching style; users can adjust the space to suit the purpose and the number of people. Dedicated outdoor spaces with sockets and furniture allow for working in fresh air (Figure 14).

Figure 14. Flexible infrastructure at HPI D-School: Moveable furniture on wheels; outdoor team booth allows working outside; moveable walls for flexibility.

3.3.4 Space as a social dimension. Social interactions among co-workers and between students and teachers are an important aspect of creative work. By definition, team spaces are usually designed to allow social interactions; but intermission spaces such as cafés or hallways might enforce accidentally running into each other, which might also support the exchange of information. The strategic placement of central objects, such as copy machines or water coolers, could facilitate social interactions.

HPI D-School housed many casual meeting spots, such as sofas and coffee corners that invite social interaction. Furthermore, entrance areas and the elevator were mentioned as spaces for casual meetings and discussions with classmates. Transparent walls and bookshelves allowed for visual contact (Figure 15).

Figure 15. Social dimension at HPI D-School: Elevator as meeting spot; casual sofas invite personal exchange; transparent walls and shelves allow visual contact.

3.3.5 Space as a source of stimulation. The space can act as a source of stimulation by providing noise, smell, views, colours, and textures; by displaying inspirational posters; or by providing games and gadgets. That being said, a space may also trigger creativity by reducing stimulation. The lack of textures and noise might facilitate a creative flow (Csikszentimihalyi, 1996). Many participants mentioned that silent and non-distracting atmospheres in nature, or being on a train with passing landscapes, facilitated their creative output. In addition, some stimulation, such as loud noise that impedes concentration, might have a negative effect on creative workflow.

At HPI D-School, positive stimulation was achieved through natural sounds and smells while working outdoors, whereas the noise level of co-workers was often a cause for distraction and negative stimulation. In addition, the choice of background music was sometimes grounds for disagreement. Further stimulation was provided through colourful interiors (Figure 16).

Figure 16. Stimulation at HPI D-School: Open space with loud background noise (negative); colourful interior.

3.4 Summary

The presented typology of creative spaces distinguishes between five space types and five spatial qualities that appeared to be relevant and sufficient to cover all required spatial concepts in the analysed institution.

The five identified space types—personal space, collaboration space, presentation space, making space, and intermission space—were categorized based on the affordance they provided for particular design and learning activities. One might argue that any space can be used for any designerly activity, which is certainly true; but usually a space provides some kind of optimization for specific intended activities. For example, a space in a library could certainly be used for model-making, or a wood workshop for a lecture; but those spaces would not be the best choice for these activities. The inherent purpose of a space is explained with the concept of affordance (Norman, 1999); the presented typology employs this concept.

The spatial qualities derived from the data suggested a certain range between positive and negative dimensions of each quality, depending on the extent to which it is present and on the respective context. For example, the stimulating quality of a space may be either inspiring or distracting; a space as a knowledge processor can be accessible or locked; a space as a social dimension can be inviting or separating; a space as an indicator of culture can be playful or serious; and a space as a process manifestation can be either flexible or fixed.

Each space type comprises all five spatial qualities, however in different shapes and degrees. Table 1 outlines the suggested requirements for the spatial qualities according to each space type.

Table 1 Possible requirements of space types related to spatial qualities

	Knowledge Processor	**Indicator of Culture**	**Process Enabler**	**Social Dimension**	**Source of Stimulation**
Personal Space *should / might:*	– protect knowledge – provide access to explicit knowledge	– indicate privacy – provide separation from others – express individuality	– provide secluded booths – provide appropriate equipment	– reduce social interactions	– be protected from external stimulation – provide individually adjustable stimulation
Collaboration Space *should / might:*	– provide access to knowledge – display explicit knowledge – enable tacit knowledge exchange	– indicate rules for usage/behaviour – be accessible – be playful – facilitate common rituals	– facilitate teamwork – provide collaboration furniture – include flexible and moveable furniture	– invite and enable interactions – provide meeting areas	– provide visual and acoustic stimulation – allow higher noise level – limit noise level to acceptable degree
Making Space *should / might:*	– provide instructions for usage – display artefact knowledge	– invite experimentation – invite trial-and-error – allow noise and dirt	– provide materials – provide making infrastructure	– facilitate task-related social interactions	– allow higher noise/dirt level – limit noise/dirt to acceptable degree
Presentation Space *should / might:*	– facilitate knowledge transfer – display artefact knowledge	– upvalue/highlight presenter or work – enable/encourage feedback	– provide infrastructure for presenting – provide a platform to display/ present work	– invite feedback/ discussions	– reduce external distraction – presentation should become main stimulation

	Knowledge Processor	Indicator of Culture	Process Enabler	Social Dimension	Source of Stimulation
Intermission Space *should / might:*	– facilitate knowledge transfer – display knowledge of general interest – provide access to field/user research	– be inviting, cosy, welcoming, or representative – facilitate common rituals	– provide outdoor access – provide recreation area – provide access to suppliers – be in proximity to other spaces	– facilitate coincidental meetings – enable collective breaks	– provide fresh air and/or food – provide reduced stimulation – provide natural stimulation

The participants in the study also indicated that specific characteristics of spatial elements—such as materials, views, smells, textures, colours, or a particular piece of furniture—had positive or negative influences on their creative workflow, mood, and performance. However, these insights are not part of this study; they will be investigated further in future work.

4. Validation

To validate the developed typology of creative space types and spatial qualities, as described in the previous section, we conducted a second study at another institution: an associated institute of the University of Kassel/Germany ('Uni Kassel Transfer'). This institution is a research facility and co-working space wherein collaboration between students, staff, start-ups, and practitioners is facilitated. Hence, this study provided us with the perspective of additional practitioners and academic teaching staff. The goal of the validation study was to identify whether the typology is (a) exhaustive, (b) understandable, and (c) without unnecessary categories.

4.1 Method

We invited nine participants from different creative backgrounds (design teachers and research assistants, independent design practitioners, founders of creative start-up companies, and employees of global companies) to a focus group workshop, following the procedure laid out in Edmunds (1999). The institution and participants were chosen based on the following consideration: to validate the developed typology and to determine whether it can be adapted for different types of creative environments and stakeholders, we chose to test it again with non-student participants to obtain more diverse perspectives on the topic. The type of institution—a university-affiliated research centre and incubator—provided additional

insights about different possible types of creative work activities other than those in a design thinking school. Hence, varying both the target population and the research approach should enhance the validity of the results.

In preparation for the workshop the participants were asked to document their own work environments and to provide ideas and suggestions as to how to design a co-working space for a heterogeneous cohort of creative people. They were asked to provide pictures of their current workspaces as well as ideas, thoughts, and statements about their ideal co-working space. The prepared material was delivered to and analysed by three researchers in preparation for the workshop.

We invited all nine participants to a focus group workshop to discuss their material together and to evaluate their provided data compared with the previously defined typology of creative spaces. During the one-day workshop, the participants were teamed up in groups of two or three. Each team was asked to analyse their material and explain the results to each other. Each team was supported by one researcher who took notes or made visual sketches from the most promising statements and insights. Each team then presented its findings to the entire group. Finally, participants were asked to cluster the notes and sketches according to different space types and spatial qualities. Although they had heard a brief presentation about our previously developed typology at the beginning of the workshop, they were asked to define their own labels for space types or to create new ones if the provided structure would not suffice and they identified additional space types and functions. The resulting ideas and questions were discussed with the goal of sharing the different perspectives. A detailed description of this study is available in a different publication (Thoring, Luippold, Mueller, & Badke-Schaub, 2015).

4.2 Results

The suggested typology of creative spaces and qualities was mainly validated through the present study. The participants came up with the same types of spaces, plus another space type, which they called the ‘virtual space’. This space type mainly suggested virtual meeting rooms for collaboration with co-workers in remote locations, as well as access to databases with specific materials, information, or additional manpower (expertise). Although this aspect of a space merits further research, we considered it not as an additional space type, but as a characteristic of the technical infrastructure and hence a part of the process enabler category. Such a virtual space could be either a collaborative space (e.g. a virtual meeting room), a personal space (e.g. a blog for personal thoughts), a presentation space (e.g. a pre-recorded

video lecture), a making space (e.g. a so-called ‘sandbox’ in which to build digital prototypes), or an intermission space (e.g. Skype or other video conferencing systems that connect remote locations). Hence, we consider the virtual aspect a characteristic of a space rather than a space type of its own.

The study also validated the five spatial qualities. Although individual participants identified different characteristics of each quality, the overall findings confirmed the main categories of spatial qualities as described in our typology. The participants emphasized one additional characteristic of a spatial quality: data privacy. The ability to hide data in locked file cabinets or behind blinds was very important for most practitioners. However, we considered this not as an additional quality of a space, but as a characteristic of the ‘knowledge processor’—which can be represented in several degrees of accessibility. Considering the initial question that informed the study, we found that (a) the typology’s categories were exhaustive, (b) all categories were understood by the participants, and (c) the typology did not show unnecessary categories. Hence, this second study serves to validate the proposed typology of creative spaces.

5. Discussion

According to the typology described above, some relationships between space type and quality appear relevant for facilitating creative working and learning in a design environment. The data suggest that a creative environment needs all five types of spaces, albeit in different shapes, proportions, and alignments. A lack of a particular space type resulted in unsatisfied users, leading them to improvise adaptations of other spaces. Whether a space was deemed good or bad for creative working and learning activities was mainly determined by the characteristics of the respective qualities that the space provides. These qualities can be perceived as positive or negative, depending on the respective process phase, the individual preferences and needs of the users, or the extent of the quality in question.

Another aspect to consider is the amount of available resources in terms of time, budget, and space. Sometimes an institution must economise and remain in a small space, or it must deal with an existing building that cannot be extended. With the presented typology, we do not suggest any specifics of appropriate furniture or appearances, but only systemic guidelines that could be followed in different degrees with various financial and spatial resources.

Consequently, it is impossible at this point to coherently rank the different space types and qualities in any particular order of relevance or to suggest specific design guidelines. Instead, all space types and all qualities should be considered when designing a creative space, and concrete specifications and design decisions should be carefully balanced in adjustment with the applicable situation. Nevertheless, the following section presents a few rules of thumb to consider when designing creative spaces.

5.1 Implications

A space's capacity to transform from one type to another seems to be an important merit, because sometimes different activities must occur in a single space within a short timeframe (e.g. presentations followed by groupwork). This flexibility of a space is mainly determined by a flexible infrastructure—that is, the degree to which the space allows the changeover from one type to another with minimal effort. The process enabling quality of presentation spaces and intermission spaces also needs special attention. When presentations occur only sporadically, a highly flexible infrastructure is preferable to allow for collaboration or individual work at other times.

A good balance of all different space types seems to be critical for a smooth workflow and a lack of particular space types might result in unsatisfied users. Specifically, personal spaces for individual work were underrepresented in the analysed institution. In addition, it might be necessary to combine several space types in a single room or to distribute them across the campus according to available resources. In either case, designers must consider the problems and opportunities—for example, rising noise levels when combining space types, or additional transition time between separated spaces—that might emerge.

The expressed culture within a space plays an important part in encouraging active experimentation. For example, a making space that motivates students to actively take risks and experiment might facilitate experiential learning, according to Kolb (1984).

Sensory stimulation (e.g. noise, sound, smell, dirt) can be inspiring, especially for creative work, but too much of it also presents a risk for distraction. Hence, reduced stimulation might be desirable in personal and intermission spaces.

Intermission spaces between different space types (e.g. hallways) necessitate time and effort to transfer from one space type to another. This would suggest that most space types should be placed in close proximity to each other. However, this would minimize the potential of intermission spaces for social interaction and reflection.

Presentation spaces and lecturing remain important; a lot of teaching and sharing of ideas still takes place through transfer of explicit knowledge. In the design context, however, other types of knowledge transfer and knowledge generation are also important. Specific attention should be given to the design of consultation spaces (a subcategory of the collaboration space), because feedback from teachers, classmates, co-workers, and clients is crucial for the transfer of implicit design knowledge. Furthermore, artefact knowledge embedded in work models and tools should be present. See Mueller & Thoring (2010) for an overview of different types of design knowledge.

Furthermore, the literature shows that virtual spaces are becoming more relevant for designers and design students to help them facilitate information retrieval, connect with co-workers and fellow students, and replace physical meeting spaces and lecture rooms. This is illustrated in virtual learning spaces, the rise of massive open online courses (MOOCs) and distance design education programmes (Sköld, 2011; Weiss, Nolan, Hunsinger, & Trifonas, 2006), as well as virtual office environments in creative organizations. The virtual aspects range from facilitation of remote working (home office) to virtual reality environments with avatars to simulate team collaboration online. Several aspects of virtual workspaces along with advantages and disadvantages have been discussed, for example, by Thomas (2013), or Zemliansky & St. Amant (2008). Virtual spaces can provide a place for virtual communities and a way for geographically distributed people to communicate (Maher, Skow, & Cicognani, 1999) and facilitate creative activities, such as brainstorming (Bhagwatwar, Massey, & Dennis, 2013). Bridges and Charitos (1997) elaborated on the possible relevance of architectural design knowledge for designing virtual environments.

Moreover, the increased use of mobile devices by designers and students requires creative spaces with an appropriate technical infrastructure, such as sockets and wireless internet access, specifically in intermission spaces like hallways or outdoor areas, where those resources are usually under-represented. Although we do not focus on the specific characteristics and design features of a virtual space, we do emphasize the relevance of physical spaces to facilitate virtual access and connectivity as a space's process enabling quality. The typology of creative spaces presented in this article might serve as a foundation for future research in the area of virtual creative spaces or for developing appropriate design specifications for collaborative spaces in the virtual world.

5.2 Comparison with Related Literature

The literature review described in Section 1 revealed a significant interest in the topic of creative spaces. We limited our discussion to those sources that suggested frameworks for creative spaces, because this is also the goal of our study. Table 2 juxtaposes the space types and qualities from our developed typology with comparable concepts found in the 15 analysed classifications.

Table 2 Comparison of the presented typology of creative spaces and qualities with classifications found in related literature

Space Type	Sources
Personal Space	Setola and Leurs (2014) > The attic (analyse and generalise) Lawson and Dorst (2009) > Library (study room) Williams (2013) > Informal spaces at work for privacy Meinel et al. (2017) > Doodle space Doorley & Witthoft (2012) > Home base, focus
Collaboration Space	Setola and Leurs (2014) > The pub (share and compare) Setola and Leurs (2014) > The attic (analyse and generalise) Lawson and Dorst (2009) > Studio, tutoring space, crit room (all address students' teamwork) Williams (2013) > Official workspace, semi-official workspace Doorley & Witthoft (2012) > Home base, gathering space
Making Space	Setola and Leurs (2014) > The workplace Doorley & Witthoft (2012) > Realization space
Presentation Space	Doorley & Witthoft (2012) > Gathering space
Intermission Space	Setola and Leurs (2014) > The wild (observe and register) Williams (2013) > Informal spaces at work for engagement, non-workspace (home, outdoor, transportation, etc.) Meinel et al. (2017) > Relaxing space, disengaged space, doodle space Doorley & Witthoft (2012) > Thresholds/transitions, reflect

Spatial Quality	Sources
Knowledge Repository	Leurs et al. (2013) > Make Sense (meaning making) Lawson and Dorst (2009) > Library (repository of design literature and precedents) Moultrie et al. (2007) > Data and information
Organizational Culture	Leurs et al. (2013) > Make Place (ownership) Walter (2012) > Organizational climate for creativity Moultrie et al. (2007) > Design values and imagery Lindahl (2004) > Symbolic qualities (corporate image and identity) Doorley & Witthoft (2012) > Attitudes
Source of Stimulation	Meinel et al. (2017) > Unusual/fun space Meinel et al. (2017) > Complexity (spatial layout)
Process Enabler	Leurs et al. (2013) > Make place (setup), transparency (accessibility)

	Moultrie et al. (2007) > Geographic location, physical scale, real/virtual, flexibility, IT resources, modelling and visualization resources. Williams (2013) > Affordances Meinel et al. (2017) > Spatial layout (flexibility, office size, office layout) Lindahl (2004) > Spatial configuration (dependencies between activities and spatial setting) Lindahl (2004) > Work environment qualities (health and safety) Doorley & Witthoft (2012) > Posture, orientation, surface, density, storage, support structure Walter (2012) > Flexibility, access (conceptual feature of the workplace)
Social Dimension	Williams (2013) > Behaviour (engage or disengage with people) Meinel et al. (2017) > Privacy (spatial layout) Walter (2012) > Group interaction/solitude (conceptual feature of the workplace) Lindahl (2004) > Quality and degree of participation

Additional Concepts	**Sources**
Spatial Characteristics	Dul & Ceylan (2011) > 12 Characteristics: furniture, indoor plants, calming colors, inspiring colors, privacy, window views (nature), any window view, quantity of light, daylight, indoor climate, sound, and smell. Martens (2008) > layout, furniture, colour, finishing, and light Meinel et al. (2017) > Tangible office elements, intangible office elements Williams (2013) > 6 Properties: comfort, sound, sight, spaciousness, movement, aliveness Walter (2012) > Physical features of the workplace (light, air, furniture, etc.)
People/Behaviour	Greene and Myerson (2011) > Types of Knowledge Workers Williams (2013) > Behaviour (engage or disengage with ideas) Doorley & Witthoft (2012) > Actions (Synthesize, flare, saturate)
Other Influences	Moultrie et al. (2007) > External Constraints e.g. Finances Moultrie et al. (2007) > Evolution of Environment according to companies' needs Walter (2012) > Ubiquity, Variety (conceptual features of the workplace)

The comparison in Table 2 shows that the 15 analysed sources define similar space types as we do, but mostly not in as much detail as in our proposed typology. While many studies suggest some sort of personal space and collaboration space, making spaces and presentation spaces are rarely addressed. Walter (2012) does not distinguish between space types for different activities but mentions only the creative process as a whole. On the other hand, some sources suggest unnecessary detail and define several sub-categories for a concept that could be summarized under one term. For example, Meinel et al. (2017) distinguish between relaxing space and disengaged space (for non-work-related activities), which in our view, does not justify a new category on its own. Most sources suggest some sort of spatial quality, as we do. However, our quality of spatial 'stimulation' is rarely addressed by the analysed sources, although we consider this a crucial aspect of a creative

space. Some sources suggest additional categories of creative spaces, for example external influences, such as financing (Moultrie et al., 2007) or specific behaviours of people within space (Doorley & Witthoft, 2012; Greene & Myerson, 2011; Williams, 2013), which, however, we do not consider relevant categories for the physical creative environment. Several sources suggest specific characteristics of creative spaces, such as materials, furniture, colours, smells, sound, etc. These are certainly a valid amendment to a typology of creative spaces, but we did not yet incorporate such elements into our typology for the following reasons: We consider those spatial characteristics as such as not relevant for categorizing a creative space. Any space consists of certain appearances and configurations of furniture, materials, colours, and so on. But decisions for any specification of such elements are not contributing to the understanding of a creative space, unless they are underpinned by possible causal relationships in the sense that one spatial characteristic might influence the creative process or outcome in a specific way, which the analysed sources do not provide. In future work we will tackle the attempt to develop such a theory of the causal relationships between spatial characteristics and creativity. Refer to Table 2 for a detailed overview and mapping of the concepts from our typology with the analysed sources.

5.3 Limitations and Relevance

One limitation of the present study is that it only considers institutions in a single country. This raises questions about the possible influence of national culture on creative environments that will be addressed in future work.

We expect the presented typology to provide valuable insights for designers, educators, and spatial planners who are involved in designing or optimizing creative work and study environments. Given that the typology was developed and tested in two different types of institutions (a design thinking school, and a university-affiliated research facility), involving participants from both design practice and design education, we argue that the results are generalizable and can be transferred to other institutions, as well as to the corporate sector. The actual design and the characteristics of the particular space types and qualities might differ according to the needs of the different stakeholders and to personal preferences, but the space types and qualities as suggested by the typology are relevant for any design process and warrant careful consideration when planning a creative space. However, we are aware that these hypotheses have to be further investigated through additional studies to cross-validate the findings.

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