



Delft University of Technology

## **Creative space**

### **A systematic review of the literature**

Thoring, Katja; Desmet, Pieter; Badke-Schaub, Petra

#### **DOI**

[10.1017/dsi.2019.33](https://doi.org/10.1017/dsi.2019.33)

#### **Publication date**

2019

#### **Document Version**

Final published version

#### **Published in**

Proceedings of the International Conference on Engineering Design, ICED

#### **Citation (APA)**

Thoring, K., Desmet, P., & Badke-Schaub, P. (2019). Creative space: A systematic review of the literature. *Proceedings of the International Conference on Engineering Design, ICED, 2019-August*, 299-308. <https://doi.org/10.1017/dsi.2019.33>

#### **Important note**

To cite this publication, please use the final published version (if applicable). Please check the document version above.

#### **Copyright**

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

#### **Takedown policy**

Please contact us and provide details if you believe this document breaches copyrights. We will remove access to the work immediately and investigate your claim.

## CREATIVE SPACE: A SYSTEMATIC REVIEW OF THE LITERATURE

Thoring, Katja (1,2); Desmet, Pieter (1); Badke-Schaub, Petra (1)

1: TU Delft, The Netherlands; 2: Anhalt University of Applied Sciences, Germany

### ABSTRACT

This paper provides an overview of the state-of-the-art research about creative work and learning environments. We conducted a systematic literature search within the Scopus database and identified a total of 70 relevant sources discussing creative spaces within academic, practice, or other innovation environments. Among the included sources are 48 academic publications and 22 sources from company research and illustrative coffee-table books that are discussed separately. We analyse the academic sources regarding their theoretical contribution, as well as regarding their scope. Finally, the included sources are categorized according to three areas of interest: (1) the addressed space types for different creative activities, (2) abstracted requirements for creative spaces, and (3) concrete characteristics and configurations of a creative space. The results provide an in-depth insight into the current state of research on the topic of creative spaces. Practitioners, educators, and researchers can use the presented overview to investigate the possible impact of creative workspace design and to identify research gaps for conducting further research in the field.

**Keywords:** Workspaces for design, Creativity, Design management, Creative space, Literature Review

### Contact:

Thoring, Katja  
TU Delft  
Industrial Design Engineering  
The Netherlands  
k.c.thoring@tudelft.nl

**Cite this article:** Thoring, K., Desmet, P., Badke-Schaub, P. (2019) 'Creative Space: A Systematic Review of the Literature', in *Proceedings of the 22nd International Conference on Engineering Design (ICED19)*, Delft, The Netherlands, 5-8 August 2019. DOI:10.1017/dsi.2019.33

## 1 INTRODUCTION

We define creative spaces as physical structures and elements at different scales that are deliberately designed to support creative (e.g. designerly) work processes or to facilitate creativity and innovation. The scales of the physical structures and elements can vary from single items and pieces of furniture to the room's layout and interior design, and from the architectural building to the location within a specific civic context. It covers spaces in both educational and corporate environments, as well as special forms such as innovation labs. While there has been a lot of research on work environments in general, the research about the specifics of creative spaces is still in its beginnings. At the same time, creative and playful work environments are implemented worldwide in companies such as Google or WeWork, and in design educational contexts as well. What is missing is a holistic understanding of the possible impact of the workspace design on creativity and innovation activities. As Amabile stressed, "there is almost no empirical research on the effects of work environments on creativity" (Amabile, 1996, p. 210). However, since the publication of her (updated) book in 1996, numerous studies have been conducted that addressed this topic. This leads to the following research question:

*RQ: How can the spatial design of workspaces in academic and corporate environments facilitate creativity and innovation, according to the current state of the literature?*

With this paper, we aim to provide an overview of the state-of-the-art research on creative workspaces by presenting a systematic literature review. Practitioners, educators, and researchers can use this overview to better understand the possible impact of creative workspace design and to identify research gaps for conducting further research in the field.

## 2 METHODOLOGY

We conducted a three-step keyword search within the Scopus database to identify relevant sources. More specifically, we searched for literature on (1) creative spaces in educational contexts, (2) creative spaces in work or office environments, and (3) special forms like innovation or idea labs. We included also educational contexts because here new pedagogical and also spatial concepts emerge, that might provide relevant insights to the topic. We excluded FabLabs and makerspaces from our search, because these were considered only a technical infrastructure for prototyping activities and hence not representative for the general notion of creative spaces. Similarly, we also excluded coworking spaces from our search funnel, because these were considered not specific to creative spaces, according to our definition presented in the introduction. We included idea labs and innovation labs, because these address early stages of the innovation process that are closer related to idea generation, whereas incubators and accelerators were excluded, because these focus on the later stages of the innovation process and on implementing existing ideas (Narayanan, 2017). For all three search steps, possible combinations with synonyms were also considered (e.g. space vs. environment, creative vs. innovative, office vs. work, learning vs. educational, etc.). The results were limited to peer-reviewed journal and conference publications only. Figure 1 illustrates our search and selection process.

We analysed the returned 379 sources based on their abstract. We identified papers for exclusion that were either unrelated to the topic or limited to one specific aspect of the creative environment (e.g. lighting, ergonomics of office chairs, etc.) as well as papers that addressed a peculiar (non-design-related) context, such as hospitals, libraries, or nursing homes (selection criteria A). After excluding redundant sources from all three search steps we conducted a full-text analysis on the remaining 88 sources, which left us with 29 sources identified as relevant. Our selection criterion at this point was to include only papers with a focus on the physical environment, whereas sources that regarded the environment in a rather abstract way (e.g. financial constraints, encouraging leadership, or virtual spaces) were disregarded (selection criteria B). Finally, we conducted a backward and forward citation analysis on the remaining 29 sources, in which we also included non-peer-reviewed sources such as books and PhD theses, as well as coffee-table books and corporate research that appeared to be of relevance. This procedure resulted in a total number of 48 scientific sources that were included for further analysis and 22 non-academic sources that are discussed separately. Figure xx illustrates the systematic search process.

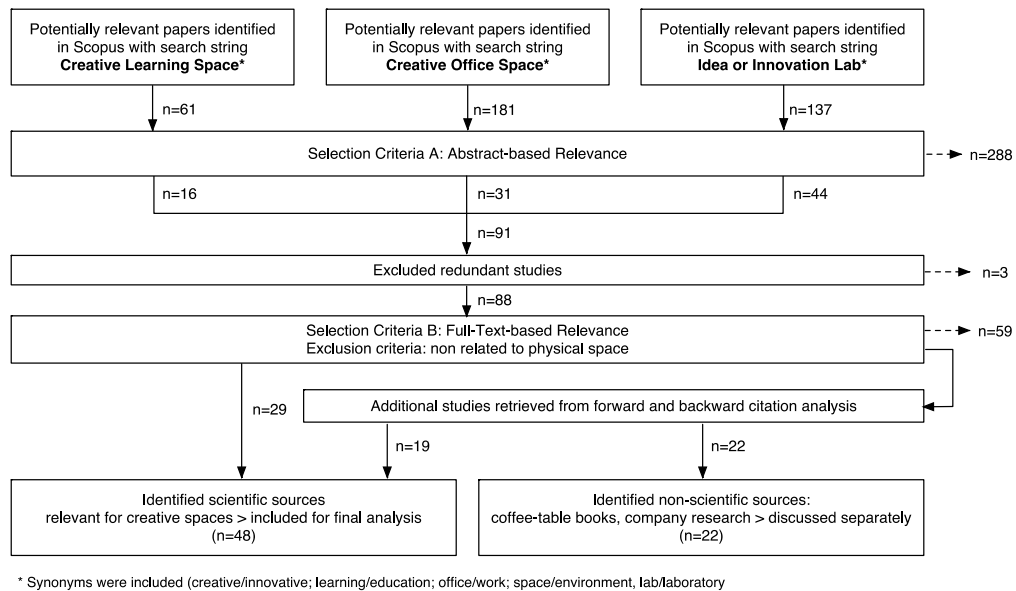


Figure 1. Systematic Literature Search

### 3 PRACTICAL RELEVANCE

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 et al., 2013](#); [Georgi and McNamara, 2016](#); [Groves et al., 2010](#); [Stewart, 2004](#)). Simultaneously, an increased interest in creative learning environments is emerging in the area of elementary schools and kindergartens (e.g. [Boys, 2010](#); [Dudek, 2012, 2000](#); [Ehmann et al., 2012](#); [Mirchandani, 2015](#)), whereas such books about creative learning space design in higher education are rarely to be found. Also, some special types of work environments, such as co-working spaces or makerspaces, are covered by such illustrated books (e.g. [Davies and Tollervey, 2013](#); [Kinugasa-Tsui, 2018](#)). However, all these publications merely present a collection of photographic case examples of peculiar creative spaces. They rarely provide any theoretical background and explanations about the possible impact of the spatial designs and are seldomly categorized systematically. Nevertheless, these examples demonstrate an increased public and corporate interest in the topic of creative working and learning environments that warrants further investigation. Interested readers can consult these sources to find inspirational examples of creative workspace designs.

At the same time, various industrial corporations conducted research about creative workspaces. While these publications are usually not peer-reviewed, they still provide novel research on various practice-related topics. Since these companies usually have access to a large number of customers or employees, they are able to conduct quantitative research that has a high practical relevance. For example, M. Arthur Gensler Jr. & Associates, Inc. (in short, known as ‘Gensler’) is an American architecture and design firm, based in San Francisco, CA. They regularly publish workspace surveys—the so called ‘Gensler Workplace Survey’, in which they present results of surveys among office workers, mainly in the U.S., but more recently they also included issues for the U.K, Asia, and most lately, Latin America. In the latest U.S. issue from 2016 ([Gensler, 2016](#), p. 3), they surveyed a panel-based sample of more than 4,000 randomly selected U.S. office workers in 11 industries. The goal of the survey was to understand “where, and how, work is happening today, and the role design plays in employee performance and innovation, [...] to provide critical insight into how the workplace impacts overall employee experience” ([Gensler, 2016](#), p. 3). One of their main findings was that “great workplace design drives creativity and innovation” ([Gensler, 2016](#), p. 3). In ([Gensler, 2008](#)) they identified four modes for successful work performance: focus work, collaboration, learning, and socializing.

American furniture manufacturer Steelcase also conducted research about various interior-related topics, such as ‘wellbeing’, ‘the privacy crisis’ at the workplace, or ‘active learning spaces’. Their findings were published in their internal magazine called 360°. Two of the latest issues are focusing on creativity and innovation at the workplace: ‘the creative shift’ ([Steelcase, 2017](#)) and ‘inside innovation’ ([Steelcase, 2018](#)), in which scientific insights, for example the effects of posture on the brain, or the impact of social interaction on creativity, are juxtaposed with Steelcase’s furniture concepts. Similarly, Knoll, another

American furniture manufacturer, regularly published short papers about various topics related to the workplace and the learning environment under the label ‘Knoll Workplace Research’. Among the presented studies were survey results and case studies, addressing, for example, ergonomic questions, start-up culture, or future work and technology trends. Of particular interest for the topic of creative spaces are the articles on “the rise of co-working” (Roth and Mirchandani, 2016), which presented statistical data and demographics about co-workers and their preferences, and “adaptable by design” (O’Neill, 2012), which addressed the importance of flexible and customizable workspace.

WeWork is an American company that provides coworking spaces for start-ups, entrepreneurs, small businesses, and freelancers. As of 2017, they manage a total of approximately 1 million square meters of office space and are valued at roughly 20 billion US\$ (Hempel, 2017). Besides interviewing their customers to enquire their satisfaction with the offered workspaces, WeWork developed several innovative research approaches to study the effect of their workspace designs. Through ‘spatial analytics’, which involves location-based data together with random enquiries through Apps or text messaging, WeWork is able to measure and count workspace usage statistics, for example, the average number of people using a conference room, or whether spaces with more phone booths would receive fewer complaints about noise distractions (Davis, 2016). Furthermore, ‘Building Information Modeling’ (BIM), which is a software-based planning tool for architects, is utilized to create detailed 3D models of their office spaces, in order to customize and optimize their office designs and make them more efficient (Rhodes, 2016).

## 4 ANALYSIS

### 4.1 Theoretical contributions

According to our research question stated above, we were particularly interested in the theoretical contribution of the identified 48 scientific sources—that is, in what way the designed spaces would be able to facilitate creativity and innovation in work and study environments. Gregor (2006) distinguished five types of theories that we used and adapted to categorize the analysed sources.

**Type 1: Theories for analyzing** that only describe and analyze the reality, for example, as a framework, classification system, typology, or as a list of categories (what is?) or requirements (what should be?).

**Type 2: Interpretative theories for explanation** that attempt to explain specific incidents (what is, how, why, when, and where?). They provide a deeper understanding of a complex situation, for example through rich, qualitative data.

**Type 3: Theories for prediction** that attempt to predict certain incidents but without providing causal explanations (what is and what will be?).

**Type 4: Causal theories for explanation and prediction** that attempt to predict specific incidents and also provide testable propositions and causal explanations (what is, how, why, when, where, and what will be?).

**Type 5: Design theories** that provide explicit prescriptions for constructing an artifact (how to do something?).

We categorized the included 48 scientific sources according to their theoretical contribution. In the following sections we discuss these sources by category.

**Theories for Analysing, Type 1.** The biggest part of the analysed sources (n=19) presented Type 1 theories that described or analysed a creative space—as is. 11 sources presented typologies, classification systems, or frameworks (Jankowska and Atlay, 2008; Kohlert and Cooper, 2017; Leurs *et al.*, 2013; Paoli and Ropo, 2017; Schmidt, Brinks and Brinkhoff, 2015; Setola and Leurs, 2014; Snead and Wycoff, 1999; Thoring *et al.*, 2012a, 2012b, 2018a; and Williams; 2013). In contrast, eight sources presented lists of requirements that a creative space should fulfil, but without detailing how exactly this could be achieved (Martens, 2008; Lindahl, 2004; Moultrie *et al.*, 2007; Narayanan, 2017; Oksanen and Stähle, 2013; Peschl and Fundneider, 2014; Walter, 2012; and Haner, 2005).

**Interpretative Theories for Explanation, Type 2.** Ten sources presented qualitative or interpretative theories that tried to explain more complex situations of particular spatial configurations, mainly based on qualitative user studies and individual opinions, such as interviews or case studies. They did not provide any testable propositions or predictions (Bryant, 2012; Cannon and Utriainen, 2013; Edström, 2014; Greene and Myerson, 2011; Groves-Knight and Marlow, 2016; Kristensen, 2004; Lewis and Moultrie, 2005; Thoring *et al.*, 2015; Törnqvist, 2004; von Thienen *et al.*, 2012).

**Theories for Prediction, Type 3.** Eight sources presented theories with predictions how a specific spatial configuration would impact creative work, but without providing explanations (Ceylan *et al.*, 2008; Dul and Ceylan, 2011, 2014; Dul *et al.*, 2011; Lin, 2009; Magadley and Birdi, 2009; McCoy and Evans, 2002; Waber *et al.*, 2014).

**Causal Theories, Type 4.** Five sources presented causal theories, outlining a causal relationship between physical workspace and creativity. (Martens, 2011; McCoy, 2005; Meinel *et al.*, 2017; Paoli *et al.*, 2017; Thoring *et al.*, 2017a).

**Design Theories, Type 5.** Four sources presented design theories that provided concrete guidelines or principles how to design a creative space (Doorley and Witthoft, 2012; Thoring *et al.*, 2018c, 2018b; van Meel *et al.*, 2010).

**Tools and Artefacts.** In addition to these different types of theories, there were two sources that presented design artefacts that would facilitate the development process of creative spaces (Thoring *et al.*, 2017b, 2016).

**Existing Literature Reviews.** Our sample revealed also several literature reviews on the topic of creative spaces (Beghetto and Kaufman, 2014; Davies *et al.*, 2013; Jindal-Snape *et al.*, 2013; McCoy, 2005; Meinel *et al.*, 2017). However, none of these appeared to be as comprehensive as our attempt. For example, Meinel *et al.* (2017) who presented the most comprehensive and rigorous literature review that culminated in a causal theory, did not include learning spaces. Moreover, their sample size of 17 articles seems rather limited. In contrast to that, Beghetto and Kaufman (2014) and Davies *et al.* (2013) focused on educational contexts only. For the purpose of our own literature review, we included these existing reviews in our co-citation analysis to identify additional relevant sources that were possibly not covered through our own search criteria.

## 4.2 Scope

This section identifies the scope of the included sources. We differentiate between educational contexts, practice-based work or office environments, innovation labs, and sources that address both, practice and educational contexts.

**Education context.** 12 sources focused on educational contexts, which includes kindergartens, elementary schools, as well as higher education institutions—either with or without a creative focus (Cannon and Utriainen, 2013; Doorley and Witthoft, 2012; Edström, 2014; Jankowska and Atlay, 2008; Leurs *et al.*, 2013; Setola and Leurs, 2014; Thoring *et al.*, 2017b, 2017a, 2016, 2012a, 2012b; von Thienen *et al.*, 2012).

**Practice contexts.** 23 sources focused on practice environments (Bryant, 2012; Ceylan *et al.*, 2008; Dul *et al.*, 2011; Dul and Ceylan, 2014, 2011; Greene and Myerson, 2011; Kristensen, 2004; Lewis and Moultrie, 2005; Lin, 2009; Lindahl, 2004; Magadley and Birdi, 2009; Martens, 2011, 2008; McCoy, 2005; Meinel *et al.*, 2017; Moultrie *et al.*, 2007; Paoli *et al.*, 2017; Paoli and Ropo, 2017; Peschl and Fundneider, 2014; Snead and Wycoff, 1999; van Meel *et al.*, 2010; Waber *et al.*, 2014; Williams, 2013).

**Education and practice contexts.** Nine sources addressed both, education and practice environments (Groves-Knight and Marlow, 2016; Kohlert and Cooper, 2017; McCoy and Evans, 2002; Oksanen and Stähle, 2013; Thoring *et al.*, 2018b, 2018a, 2018c, 2015; Walter, 2012).

**Innovation laboratories.** While there exist a substantial number of publications about innovation labs, not many of them discuss the spatial settings within these institutions but rather focus on other aspects that might or might not influence creativity and innovation, such as funding issues or organisational climate. From the initially sourced 44 studies on innovation labs, only seven were finally included in our analysis (Dul *et al.*, 2011; Haner, 2005; Lewis and Moultrie, 2005; Narayanan, 2017; Schmidt *et al.*, 2015; Thoring *et al.*, 2018c, 2015).

## 4.3 Spatial impact on creativity

The analysed 48 scientific sources presented manifold insights on various aspects of spatial designs in creative work and study environments. We searched these sources according to three criteria: (1) what different types of spaces were considered relevant for creative activities (what activity should the space support?), (2) what kind of (abstract) requirements for creative spaces were mentioned (what effect should the space provoke?), and (3) what concrete characteristics should the space have in order to facilitate creative activities (how should the space be designed?). The results from these three questions are summarized in Tables 1–3.

Table 1. Addressed space types for different creativity-related activities

Identified Space Types	Mentioned by source
Personal Space, Focus Space	Dul <i>et al.</i> (2011), Dul & Ceylan (2011), Dul & Ceylan (2014), Greene & Myerson (2011), Groves-Knight & Marlow (2016), Haner (2005), Kohlert & Cooper (2017), McCoy (2005), Meinel <i>et al.</i> (2017), Oksanen & Stähle (2013), Thoring <i>et al.</i> (2012a, 2012b, 2015, 2018a, 2018c)
Collaboration Space	Doorley & Witthoft (2012), Kohlert & Cooper (2017), Thoring <i>et al.</i> (2012a, 2012b, 2018a)
Making Space, Experimentation Space	Doorley & Witthoft (2012), Groves-Knight & Marlow (2016), Leurs <i>et al.</i> (2013), Meinel <i>et al.</i> (2017), Setola & Leurs (2014), Thoring <i>et al.</i> (2012a, 2012b, 2017a, 2018a), Walter (2012)
Exhibition Space	Lewis & Moultrie (2005), Magadley & Birdi (2009), Thoring <i>et al.</i> (2012a, 2012b, 2018a)
Presentation Space, Sharing Space	Doorley & Witthoft (2012), Lewis & Moultrie (2005), Magadley & Birdi (2009), Setola & Leurs (2014), Kohlert & Cooper (2017), Thoring <i>et al.</i> (2012a, 2012b, 2018a)
Disengaged Space, Intermission Space	Groves-Knight & Marlow (2016), Magadley & Birdi (2009), Meinel <i>et al.</i> (2017), Thoring <i>et al.</i> (2012a, 2012b, 2015, 2018a, 2018c), Williams (2013)
Relaxation Space, Wellbeing Space	Kohlert & Cooper (2017), Lin (2009), Martens (2008), Martens (2011), Meinel <i>et al.</i> (2017), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017)
Unusual Space, Play Space	Meinel <i>et al.</i> (2017), Oksanen & Stähle (2013), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017), Snead & Wycoff (1999), Thoring <i>et al.</i> (2017a, 2018b)
Virtual Space	Bryant (2012), Haner (2005), Moultrie <i>et al.</i> (2007)
Preparation Space, Exploration Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Lin (2009), Martens (2008), Martens (2011), Peschl & Fundneider (2014), Setola & Leurs (2014), Walter (2012)
Illumination Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Lin (2009), Martens (2008), Martens (2011), Walter (2012)
Verification Space, Analysis Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Leurs <i>et al.</i> (2013), Lin (2009), Martens (2008), Martens (2011), Peschl & Fundneider (2014), Setola & Leurs (2014), Walter (2012)
Incubation Space, Reflection Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Lin (2009), Martens (2008), Martens (2011), Walter (2012)

Table 2. Abstract requirements of a creative space

Identified Requirements	Mentioned by source
Social Dimension, Chance Encounters	Groves-Knight & Marlow (2016), Haner (2005), Kohlert & Cooper (2017), Kristensen (2004), McCoy (2005), McCoy & Evans (2002), Thoring <i>et al.</i> (2012a, 2012b, 2017a, 2018a), Waber <i>et al.</i> (2014)
Stimulation, Ambiance	Groves-Knight & Marlow (2016), Lin (2009), Martens (2008), McCoy (2005), Thoring <i>et al.</i> (2012a, 2012b, 2017a, 2018a), Walter (2012)
Knowledge Processing	Martens (2011), Thoring <i>et al.</i> (2012a, 2012b, 2018a)
Process Enabler, Affordances, Infrastructure	Doorley & Witthoft (2012), Groves-Knight & Marlow (2016), Haner (2005), Lewis & Moultrie (2005), Schmidt, Brinks & Brinkhoff (2015), Thoring <i>et al.</i> (2012a, 2012b, 2018a, 2018b), Williams (2013)
Engaging Space, Activate Participation	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Jankowska & Atlay (2008), Kohlert & Cooper (2017), Lindahl (2004), Paoli, Sauer & Ropo (2017), Setola & Leurs (2014)
Comfort and Ergonomics	Doorley & Witthoft (2012), Groves-Knight & Marlow (2016), Oksanen & Stähle (2013), Walter (2012), Williams (2013)
Health and Safety	Lindahl (2004), Oksanen & Stähle (2013)

Surprising, Unexpected Space	Edström (2014), Jankowska & Atlay (2008), Thoring <i>et al.</i> (2017a, 2018b), Törnqvist (2004)
Flexible Space, Changeability	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Jankowska & Atlay (2008), Haner (2005), Martens (2008), McCoy (2005), Meinel <i>et al.</i> (2017), Moultrie <i>et al.</i> (2007), Oksanen & Ståhle (2013), Setola & Leurs (2014), Thoring <i>et al.</i> (2018b), Walter (2012)
Culture of Space, Reflect Identity, Symbolic Aspects	Cannon & Utriainen (2013), Groves-Knight & Marlow (2016), Kohlert & Cooper (2017), Lewis & Moultrie (2005), Lindahl (2004), Martens (2008), Moultrie <i>et al.</i> (2007), Oksanen & Ståhle (2013), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017), Thoring <i>et al.</i> (2012a, 2012b, 2017a, 2018a, 2018b), Walter (2012), Williams (2013)
Ownership of Space	Cannon & Utriainen (2013), Leurs <i>et al.</i> (2013), Lewis & Moultrie (2005), Schmidt, Brinks & Brinkhoff (2015), Setola & Leurs (2014)
Accessibility	Moultrie <i>et al.</i> (2007), Schmidt, Brinks & Brinkhoff (2015), Thoring <i>et al.</i> (2018b)
Facilitator, Assistant	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Thoring <i>et al.</i> (2015, 2018c), Lewis & Moultrie (2005), Magadley & Birdi (2009), Narayanan (2017)
Additional Services (events, expertise etc.)	Lewis & Moultrie (2005), Oksanen & Ståhle (2013), Schmidt, Brinks & Brinkhoff (2015)

Table 3. Concrete characteristics and configurations of a creative space (# indicates number of sources)

Identified concepts	Description	#
Geographic location	Neighbouring businesses or institutions provide contacts	4
Milieus	Neighbourhoods attract creative people	3
3rd place	Cafe, home, train, etc. as workplace alternative	2
Remoteness	Dislocation from daily routine provides autonomy	6
Field Access	Mobility allows easy access to users and supplies	3
Changing Locations	Change of perspective	2
Outdoor Spaces	Nature, surrounding garden, access to fresh air	6
Open Space	Open plan office instigates communication and stimulation	9
Spaciousness	Large spaces provide 'space for thought'	6
Proximity	Short distances enable collaboration and meetings	4
Open Views	Windows to nature, sky, outdoors	12
Vistas	Views in between and across rooms; eye contact and stimulation	7
Semitransparency	Visual privacy, curtains, lamellas; protection with peeks	2
Reduced Interior	White or empty room leaves space for creative ideas	4
Complex Shapes	Ornaments and textures are visually stimulating	5
Unconventional Architecture	Asymmetry, curved walls, dead spaces; can trigger creativity	6
Buzz	Busy atmosphere, chaos, aliveness	7
Theme Park	Interiors resembling space stations, cable cars, yurts, or igloos, etc.	3
Greenery	Indoor plants, green areas, nature imagery on wallpaper	10
Gallery	Observe others without disturbing	2
Central Meeting Space	Theatre-style auditorium, forum for intense group meetings	4
Face-to-Face Meeting Space	Shared rooms or 2-by-2 seating arrangements for intense talks	12
Informal Lounge Area	Sofas, hallway seating for casual meetings	4
Cozy Capsule	Booths, small room-in-a-room for personal withdrawal	4
Flex Desk, Hot Desk	Flexible workspaces instigate new connections every day	2
Personalized Space/Items	Assigned workspaces or objects allow for personal expression	5
Cafe, Kitchen	Hub for casual meetings	6
Writeable Surface	Displayed knowledge and visual thinking on whiteboards etc.	14
Anchors	Attractors or spatial bottlenecks instigate chance encounters	4



Information Access	Book library or access to digital sources	4
Technical Infrastructure	Wifi, rapid prototyping, printing, electronic brainstorming etc.	16
Access to Equipment	Materials and tools are visible and ready to use	16
Visual Inventory of Tools	Indicate what tools are available and how to use them	4
Toys and Games	Computer games, table tennis, etc. for inspiration and distraction	7
Gym	Sports facilities to workout	3
Unusual Furniture	Hammock, beanbag, etc. indicate that casual breaks are permitted	4
Activating Furniture	High chairs or swivel chairs enforce bodily movement	6
DIY Style	Old furniture and rough materials instigate experimentation	2
Communal Table	Shared desks; work in company but not necessarily together	4
Interim Showcase	Exhibitions of project work or models, e.g. combined with storage	4

For all three tables we included only those spatial concepts that were mentioned by more than one source. Also, we excluded concepts that remained very vague and unspecific (e.g. some sources mentioned “furniture”, “view”, or “presence of computers”, without providing any details, which does not demonstrate relevant information for creative spaces.) Numerous characteristics addressed sensory aspects of a space, such as colours (cool, warm, pale, bright), different light situations (natural, artificial), temperatures, air quality, sounds (positive, negative, distracting), smells, and haptics. We did not include these insights in the current version of the paper, because of page limitations. The complete list of spatial characteristics that were identified as relevant for creative spaces, along with the names of the sources mentioning these concepts, is available upon request.

## 5 DISCUSSION

The analysed literature revealed that the topic of creative environments attracts interest in various disciplines. There are attempts to address the field from different perspectives, such as theoretical investigations or as prescriptive guidelines and tools. It becomes apparent that the majority of the analysed sources provide only descriptions or analyses of the status-quo of creative spaces (type 1 or 2 theories). Some go a step further and present also predictions how spatial configurations might impact creative behaviour (type 3 theories), but without providing explanations for the possible working mechanisms. Only five sources presented causal (type 4) theories that provide not only predictions for certain impact along with theoretical explanations, but also testable propositions. However, none of the respective papers appears to be comprehensive in terms of scope, empirical evidence, and theoretical underpinning, which indicates that the need for a holistic causal theory of creative spaces still persists. Similarly, the offered tools and design principles (type 5 design theories) are either not sufficiently evaluated, or they address a rather narrow target (e.g. design education). In summary, the analysed sources all come to the conclusion that a deliberate and inspiring design of workspaces is important and that it can have an actual impact on creativity. However, most of them do not specify how exactly those spaces should be designed. Consequently, the presented sources seem to not adequately cover the persisting demand of practitioners for clear instructions how to design creative spaces, along with underlying working principles, which presents also great opportunities for future research.

## REFERENCES

- Amabile, T.M. (1996), *Creativity in Context*. Westview Press, Boulder.
- Beghetto, R.A. and Kaufman, J.C. (2014), “Classroom contexts for creativity.” *High Ability Studies*, Vol. 25, p. 53–69.
- Borges, S., Ehmann, S. and Klanten, R. (2013), *Work scape: new spaces for new work*. Gestalten, Berlin.
- Boys, J. (2010), *Towards Creative Learning Spaces: Re-Thinking The Architecture of Post-Compulsory Education*. Routledge, London.
- Bryant, M.E. (2012), Physical Environments Conducive to Creativity and Collaboration Within the Work Environment (*Master Thesis*).
- Cannon, D. and Utriainen, T.M. (2013), “Spaces supporting creative design work”, in: *Proceedings of E&PDE 2013 International Conference on Engineering and Product Design Education*, Dublin, Ireland.
- Ceylan, C., Dul, J. and Aytac, S. (2008), “Can the office environment stimulate a manager’s creativity?” *Human Factors and Ergonomics in Manufacturing & Service Industries*, Vol. 18, p. 589–602.
- Davies, A. and Tollervey, K. (2013), *The Style of Coworking: Contemporary Shared Workspaces*. Prestel, Munich.

- Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P. and Howe, A. (2013), "Creative learning environments in education—A systematic literature review". *Thinking Skills and Creativity*, Vol. 8, p. 80–91.
- Davis, D. (2016), "Spatial Analytics: New Ways of Understanding Architecture at WeWork R&D". WeWork Blog.
- Doorley, S. and Witthoft, S. (2012), *Make Space: How to Set The Stage For Creative Collaboration*. John Wiley & Sons, Hoboken, N.J.
- Dudek, M. (2012), *Spaces for young children: A practical guide to planning, designing and building the perfect space*, 2nd Revised edition. ed. National Children's Bureau Enterprises Ltd, London.
- Dudek, M. (2000), *Architecture of schools: The new learning environments*. Routledge, New York.
- Dul, J. and Ceylan, C. (2014), "The impact of a creativity-supporting work environment on a firm's product Innovation performance". *Journal of Product Innovation Management*, Vol. 31, p. 1254–1267.
- Dul, J. and Ceylan, C. (2011), "Work environments for employee creativity". *Ergonomics*, Vol. 54, p. 12–20.
- Dul, J., Ceylan, C. and Jaspers, F. (2011), "Knowledge workers' creativity and the role of the physical work environment". *Human Resource Management*, Vol. 50, p. 715–734.
- Edström, A.-M. (2014), "Exploring intentional instability as a quality of a learning environment". *Art, Design and Communication in Higher Education*, Vol. 13, p. 117–134.
- Ehmann, S., Borges, S. and Klanten, R. (2012), *Learn for life: New architecture for new learning*. Gestalten, Berlin.
- Gensler (2016), "U.S. Workplace Survey 2016". Gensler.
- Gensler (2008), "2008 Workplace Survey", Gensler, U.K.
- Georgi, W. and McNamara, C. (2016), *The other office 2: Creative workplace design*. Frame Publishers, Amsterdam.
- Greene, C. and Myerson, J. (2011), "Space for thought: Designing for knowledge workers". *Facilities*, Vol. 29, p. 19–30.
- Gregor, S. (2006), "The nature of theory in information systems". *MISQ*, Vol. 30, p. 611.
- Groves, K., Knight, W. and Denison, E. (2010), *I wish I worked there! A look inside the most creative spaces in business*. Wiley, Hoboken, N.J.
- Groves-Knight, K. and Marlow, O. (2016), *Spaces for innovation: The design and science of inspiring environments*. Frame Publishers, Amsterdam.
- Haner, U.E. (2005), "Spaces for creativity and innovation in two established organizations". *Creativity and innovation management*, Vol. 14, p. 288–298.
- Hempel, J. (2017), "This Is Why WeWork Thinks It's Worth \$20 Billion | Backchannel". Wired.
- Jankowska, M. and Atlay, M. (2008), "Use of creative space in enhancing students' engagement". *Innovations in Education and Teaching International*, Vol. 45, p. 271–279.
- Jindal-Snape, D., Davies, D., Collier, C., Howe, A., Digby, R. and Hay, P. (2013), "The impact of creative learning environments on learners: A systematic literature review". *Improving Schools*, Vol. 16, p. 21–31.
- Kinugasa-Tsui, K. (2018), "Co-Working Space Design". Images Pub, S.I.
- Kohlert, C. and Cooper, S. (2017), *Space for Creative Thinking: Design Principles for Work and Learning Environments*, 1st ed. Callwey, München.
- Kristensen, T. (2004), "The physical context of creativity". *Creativity and innovation management*, Vol. 13, p. 89–96.
- Leurs, B., Schelling, J. and Mulder, I. (2013), "Make space, make place, make sense", in: *Proceedings of E&PDE 2013, the 15th International Conference on Engineering and Product Design Education*. Dublin, Ireland.
- Lewis, M. and Moultrie, J. (2005), "The organizational innovation laboratory". *Creativity and innovation management*, Vol. 14, p. 73–83.
- Lin, S.Y. (2009), *Physical Workspace and Creative Performance*. Sun Yat-Sen University.
- Lindahl, G.A. (2004), "The innovative workplace: An analytical model focusing on the relationship between spatial and organisational issues". *Facilities*, Vol. 22, p. 253–258.
- Magadley, W. and Birdi, K. (2009), "Innovation labs: an examination into the use of physical spaces to enhance organizational creativity". *Creativity and innovation management*, Vol. 18, p. 315–325.
- Martens, Y. (2011), "Creative workplace: Instrumental and symbolic support for creativity". *Facilities*, Vol. 29, p. 63–79.
- Martens, Y. (2008), "Unlocking creativity with physical workplace", in: *Proceedings of the CIB W070 Conference in Facilities Management*. Heriot Watt University, Edinburgh, Scotland.
- McCoy, J. (2005), "Linking the physical work environment to creative context". *The Journal of Creative Behavior*, Vol. 39, p. 167–189.
- McCoy, J.M. and Evans, G.W. (2002), "The potential role of the physical environment in fostering creativity". *Creativity Research Journal*, Vol. 14, p. 409–426.
- Meinel, M., Maier, L., Wagner, T. and Voigt, K.-I. (2017), "Designing creativity-enhancing workspaces: A critical look at empirical evidence". *Journal of Technology and Innovation Management*, Vol. 1, p. 1–12.
- Mirchandani, N. (2015), *Future Schools: Innovative Design for Existing and New Build*. Riba Enterprises, Newcastle upon Tyne.
- Moultrie, J., Nilsson, M., Dissel, M., Haner, U.E., Janssen, S. and Van der Lugt, R. (2007), "Innovation spaces: Towards a framework for understanding the role of the physical environment in innovation". *Creativity and innovation management*, Vol. 16, p. 53–65.

- Narayanan, V.K. (2017), "Idea labs: instituting an innovation discovery process capable of sustaining the business". *Strategy & Leadership*, Vol. 45, p. 27–36.
- Oksanen, K. and Ståhle, P. (2013), "Physical environment as a source for innovation: investigating the attributes of innovative space". *Journal of Knowledge Management*, Vol. 17, p. 1–1.
- O'Neill, M. (2012), "Adaptable by Design, Knoll Workplace Research". Knoll, Inc.
- Paoli, D.D. and Ropo, A. (2017), "Creative workspaces – a fad or making real impact?" *Journal of Corp Real Estate*, Vol. 19, p. 157–167.
- Paoli, D.D., Sauer, E. and Ropo, A. (2017), "The spatial context of organizations: A critique of 'creative workspaces.'" *Journal of Management & Organization*, p. 1–22.
- Peschl, M.F. and Fundneider, T. (2014), "Designing and Enabling Spaces for collaborative knowledge creation and innovation: From managing to enabling innovation as socio-epistemological technology". *Computers in Human Behavior*, Vol. 37, p. 346–359.
- Rhodes, M. (2016), "WeWork's Radical Plan to Remake Real Estate With Code". *Wired*.
- Roth, K. and Mirchandani, N. (2016), "The rise of co-working: A growing workplace movement".
- Schmidt, S., Brinks, V. and Brinkhoff, S. (2015), "Innovation and creativity labs in Berlin: Organizing temporary spatial configurations for innovations". *Zeitschrift für Wirtschaftsgeographie*, Vol. 58, p. 232–247.
- Setola, B. and Leurs, B. (2014), "The wild, the pub, the attic and the workplace: A tool for negotiating a shared vision on creative learning spaces", in: *Proceedings of the 16th International Conference on Engineering and Product Design Education (E&PDE)*. University of Twente, Enschede, The Netherlands, pp. 178–183.
- Snead, L. and Wycoff, J. (1999), "Stimulating innovation with collaboration rooms". *Journal for Quality and Participation*, Vol. 22, p. 55–57.
- Steelcase (2018), "Inside Innovation (No. 73), 360°". Steelcase.
- Steelcase (2017), "The Creative Shift (No. 72), 360°". Steelcase.
- Stewart, M. (2004), *The Other Office: Creative Workplace Design*. Birkhäuser, Amsterdam.
- Thoring, K., Desmet, P. and Badke-Schaub, P. (2018a), "Creative environments for design education and practice: A typology of creative spaces". *Design Studies*, Vol. 56, p. 54–83.
- Thoring, K., Gonçalves, M., Mueller, R.M., Badke-Schaub, P. and Desmet, P. (2017a), "Inspiration Space: Towards a theory of creativity-supporting learning environments", in: *Proceedings of the Design Management Academy (DMA)*, Hong Kong, CN, pp. 1539–1561.
- Thoring, K., Luippold, C. and Mueller, R.M. (2012a), "Creative Space In Design Education: A Typology of Spatial Functions", in: *Proceedings of the E&PDE*. Antwerp, Belgium.
- Thoring, K., Luippold, C. and Mueller, R.M. (2012b), "Where do we Learn to Design? A Case Study About Creative Spaces", in: *Proceedings of the International Conference on Design Creativity*. Glasgow, UK.
- Thoring, K., Luippold, C., Mueller, R.M. and Badke-Schaub, P. (2015), "Workspaces for Design Education and Practice", in: *Proceedings of the 3rd International Conference for Design Education Researchers*. Chicago, USA, pp. 330–346.
- Thoring, K., Mueller, R.M., Desmet, P. and Badke-Schaub, P. (2018b), "Design principles for creative spaces", in: *Proceedings of the 15th International Design Conference*. Dubrovnik, Croatia.
- Thoring, K., Mueller, R.M., Badke-Schaub, P. and Desmet, P. (2017b), "A creative learning space development toolkit: empirical evaluation of a novel design method", in: *Proceedings of the 21st International Conference on Engineering Design (ICED17)*. Vancouver, Canada, pp. 245–254.
- Thoring, K., Mueller, R.M., Badke-Schaub, P. and Desmet, P. (2016), "Design the Campus: Introducing a Toolkit for Developing Creative Learning Spaces", in: *Proceeding of the International Cumulus Association Conference. Presented at the Cumulus Conference*, Nottingham, UK, pp. 358–368.
- Thoring, K., Mueller, R.M., Luippold, C., Desmet, P. and Badke-Schaub, P. (2018c), "Co-creating an idea lab: lessons learned from a longitudinal case study". *CERN IdeaSquare Journal of Experimental Innovation*, Vol. 2, p. 30–37.
- Törnqvist, G. (2004), "Creativity in time and space. Geografiska Annaler: Series B", *Human Geography*, Vol. 86, p. 227–243.
- van Meel, J., Martens, Y. and van Ree, H.J. (2010), *Planning Office Spaces A Practical Guide for Managers and Designers*. Laurence King Publishing, London, UK.
- von Thienen, J., Noweski, C., Rauth, I., Meinel, C. and Lang, S. (2012), "If You Want to Know Who You Are, Tell Me Where You Are: The Importance of Places", in: Plattner, H., Meinel, C. and Leifer, L. (Eds.), *Design Thinking Research*. Springer, Berlin, pp. 53–73.
- Waber, B., Magnolfi, J. and Lindsay, G. (2014), "Workspaces That Move People". *Harvard Business Review*, Vol. 92, p. 68–77.
- Wallas, G. (1926), *The art of thought*. J. Cape, London.
- Walter, C. (2012), "A framework for creating creative workspaces", in: *Proceedings of the European Conference on Knowledge Management (ECKM)*. Universidad Politécnica de Cartagena, Spain, pp. 1267–1274.
- Williams, A. (2013), *A grammar of creative workplaces (PhD Thesis)*. University of East London, London, UK.