



Formulating Design Indicators for Temporary Learning Environments on Brownfield Sites, Focusing on the Cognitive Characteristics of Generation Alpha

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Rapid urbanization has led to an increase in brownfields and abandoned urban spaces; simultaneously, Generation Alpha—as the first fully digital generation—exhibits distinct cognitive and behavioral characteristics, including a preference for interactive learning and multisensory experiences, mental flexibility, a need for rapid feedback, and extensive engagement with modern technologies. In terms of purpose, this study is classified as applied research; regarding its nature and methodology, it is a qualitative study employing a descriptive-analytical approach based on a systematic literature review. The research questions are as follows: What spatial and design requirements do the cognitive and behavioral characteristics of Generation Alpha impose on learning environments? How can the cognitive requirements of Generation Alpha be aligned with the physical, environmental, social, and identity-related potentials of brownfield sites? How can the design indicators for temporary learning environments on brownfield sites be categorized and operationalized? Literature pertaining to the three pillars—learning environment design, the cognitive characteristics of Generation Alpha, and brownfield regeneration—was reviewed based on specific inclusion and exclusion criteria; subsequently, the concepts were analyzed through the stages of open, axial, and selective coding. The findings resulted in a seven-dimensional framework comprising environmental safety and quality, physical flexibility, experiential quality, social interactivity, technological integration, place identity, and personalization. The study's contribution lies in elucidating the relationships between cognitive attributes, spatial requirements, and the capacities or constraints of brownfield sites. This framework is not a substitute for safety, environmental, economic, or legal assessments of the site, nor was its empirical validation conducted in the present study.

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Introduction

Rapid urbanization, industrial restructuring, and changes in land-use patterns have contributed to the emergence of brownfields and other underutilized urban areas. Although brownfields may be associated with environmental contamination, structural deterioration, functional obsolescence, and economic constraints, they can also provide opportunities for adaptive and temporary forms of urban reuse. Temporary learning environments represent one potential approach to activating such underutilized sites while responding to changing educational needs. However, their implementation requires more than the availability of physical space and must consider environmental safety, structural conditions, accessibility, and site-specific constraints. At the same time, changes in learner characteristics have challenged conventional approaches to learning-environment design. Generation Alpha, generally referring to those born from around 2010 onward, has grown up in highly digital and interactive environments. The reviewed literature associates this generation with interactive and experiential learning, multisensory engagement, rapid feedback, familiarity with digital technologies, flexibility in learning processes, and a tendency toward personalization and choice. These characteristics indicate a need for learning environments that are flexible, interactive, experiential, and capable of integrating physical and digital learning experiences. Previous studies have generally addressed brownfield regeneration, learning-environment design, and the cognitive characteristics of Generation Alpha separately. The relationship among these three domains, particularly the translation of Generation Alpha's cognitive characteristics into spatial requirements within brownfield sites, remains insufficiently integrated. Therefore, the present study aims to develop a conceptual and functional framework for identifying design indicators for temporary learning environments in brownfields, with emphasis on the cognitive characteristics of Generation Alpha. The study addresses four questions: What spatial and design requirements arise from the cognitive and behavioral characteristics of Generation Alpha? What capacities and constraints do brownfield sites present for temporary learning environments? How can the cognitive requirements of Generation Alpha be related to the physical, environmental, social, and identity-related capacities of brownfields? And how can the relevant design indicators be categorized and operationalized? The contribution of the study is to clarify the relationship between cognitive characteristics, spatial requirements, and brownfield capacities and constraints. The proposed framework is not intended to replace environmental, structural, economic, or legal site assessments, nor does the present study provide empirical validation of the framework.

Methods

This study is applied in terms of purpose and adopts a qualitative, descriptive–analytical approach based on a systematic literature review. The review focused on three interconnected domains: brownfield characteristics and regeneration, the cognitive and behavioral characteristics of Generation Alpha, and learning-environment design. The literature search was conducted over a five-month period using Google Scholar and relevant reference books. The main search keywords were “brownfields,” “Generation Alpha,” “learning environment,” and “regeneration.” The initial search identified 30 sources. After removing duplicate sources, 20 sources remained. Of these, 17 sources were examined during the screening process, and 9 sources were ultimately selected for the final analysis. The inclusion criteria comprised sources addressing the characteristics of brownfields, the characteristics of Generation Alpha, and the characteristics of learning environments. The screening process considered the relevance of the sources from physical, functional, interactive, and related perspectives. Sources that did not contribute to identifying the indicators and components of learning environments for Generation Alpha in brownfield sites were excluded from the final analysis. The selected

sources were analyzed using qualitative content analysis in three stages. In the open-coding stage, concepts related to the cognitive and behavioral characteristics of Generation Alpha, learning-environment requirements, brownfield capacities and constraints, and relevant design principles were extracted. In the axial-coding stage, similar and related codes were grouped into broader components and design indicators. In the selective-coding stage, the relationships among Generation Alpha characteristics, learning requirements, and the physical, environmental, social, and identity-related capacities of brownfields were examined and integrated into the final conceptual framework. The analysis resulted in seven dimensions: (1) spatial flexibility and adaptability; (2) experiential and multisensory learning; (3) social interaction and collaborative learning; (4) technological readiness and environmental intelligence; (5) environmental quality and livability; (6) place identity, sense of belonging, and continuity of memory; and (7) personalization and environmental choice. These dimensions were considered complementary indicators rather than a fixed weighted hierarchy.

Results

The findings indicate that temporary learning environments for Generation Alpha require an integrated approach combining cognitive characteristics, educational needs, spatial qualities, and brownfield capacities. Seven interrelated design dimensions were identified: (1) spatial flexibility and adaptability, through movable furniture, multifunctional spaces, and flexible layouts; (2) experiential and multisensory learning, supported by exploration, direct experience, and appropriate reuse of existing site features; (3) social interaction and collaborative learning, through shared spaces and indoor–outdoor connections; (4) technological readiness and environmental intelligence, including digital connectivity and interactive technologies; (5) environmental quality and livability, emphasizing safety, accessibility, and control of contamination and structural risks; (6) place identity, sense of belonging, and continuity of memory, through appropriate reuse of historical and industrial features; and (7) personalization and environmental choice, allowing learners to select spaces according to different learning preferences. These dimensions are complementary rather than independent. Brownfields represent a conditional opportunity for temporary learning environments, as existing structures may offer flexibility and place identity, while contamination, structural limitations, accessibility problems, and adaptation costs may restrict their reuse. Therefore, site safety and eligibility should be assessed before applying the proposed framework, and the seven dimensions should be treated as a portfolio rather than a fixed ranking.

Conclusions

The study developed a conceptual framework linking Generation Alpha's cognitive and behavioral characteristics with the spatial requirements and opportunities of brownfield sites. The seven dimensions emphasize flexibility, experiential learning, collaboration, technology, environmental quality, place identity, and user choice. However, brownfield reuse should be considered a conditional possibility rather than an inherent suitability of all sites. Environmental, structural, safety, accessibility, economic, and legal assessments should therefore precede design application. Since the framework was developed through qualitative literature review and content analysis, it requires empirical validation. Future studies can use Delphi, AHP, case studies, and post-occupancy evaluations to validate and contextualize the indicators. Overall, the framework provides a structured basis for integrating Generation Alpha's learning needs with the regenerative potential of brownfields while recognizing site-specific constraints.

پیشنهاد‌های پژوهش‌های آینده: ۱- اعتبارسنجی چارچوب با روش دلفی در دوسه دور با پانل متخصصان طراحی، آموزش و محیط‌زیست؛ ۲- وزن‌دهی شاخص‌ها با AHP برای بسترهای متفاوت (سایت صنعتی، معدنی، نظامی سابق)؛ ۳- مطالعه موردی تک‌سایتی با مطالعه پس‌محیطی رفتار کاربران و سنجش کیفیت محیط؛ ۴- مطالعه طولی اثر استقرار موقت بر ارزش زمین و پذیرش اجتماعی محل؛ و ۵- تدوین چک‌لیست اجرایی صلاحیت سایت برای نهادهای شهری.

بر این اساس، بازآفرینی اراضی قهوه‌ای به عنوان رویکردی پایدار و نوآورانه، می‌تواند زمینه ایجاد نسل جدیدی از محیط‌های یادگیری را فراهم کند؛ محیط‌هایی که نه تنها نیازهای آموزشی نسل آلفا را پاسخ می‌دهند، بلکه به احیای فضاهای فراموش‌شده شهری و ارتقای کیفیت زندگی اجتماعی نیز کمک می‌کنند.

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