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# Effectiveness of Evidence-Based Design Approaches for Built Environment Professional Education: A Case Study on an Urban Design Studio

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**Abstract:** Urban built environment professions are facing challenges due to the less predictable future of cities, as well as the increasing expectations from clients and the general public. It is crucial to support and inform these professions with sound evidence in order to promote the sustainability of cities. However, there have been few efforts to introduce evidence-based design (EBD) theories and frameworks into built environment professional education. This study presents an EBD framework for an undergraduate urban design studio. The effectiveness and long-term impact of EBD approaches and the framework presented were examined via learning outcomes, student reflections, and guest comments across two rounds of studio delivery. The reflections and comments were coded and analyzed using NVivo 11. The effectiveness of the EBD approach is confirmed for the premises, development, and effectiveness of urban design proposals that align with the concerns and expectations of professional guests. The wide range of evidence and techniques also fosters cross-disciplinary collaborations. This study sheds light on education in the built environment disciplines, which would further enhance the strength of relevant professions, ultimately contributing to the sustainability of society.

**Keywords:** evidence-based design (EBD); EBD framework; built environment discipline; professional education; urban design studio; effectiveness; sustainability; semantic analysis; triangulation



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## 1. Introduction

The world is facing a growing number of complex global issues, including climate change, global warming, public health, social equity, environmental problems such as ecosystem degradation, food security, as well as their cascading effects [1] and complex mechanisms and relationships [2,3]. Cities are particularly affected, with over 56% of the world's population living on just 3% of the Earth's land area in 2021; this figure is projected to increase to 68% by 2050 [4]. The COVID-19 pandemic and frequent extreme weather and natural disasters have also heightened concerns regarding urban resilience and sustainability [5] (pp. 301–328). Achieving the United Nations' Sustainable Development Goal 11 for sustainable cities and communities has become more crucial, but also more challenging [6]. Recent development trends highlight the need for versatility and flexibility in urban spaces [5] (pp. 179–210). These, combined with the unprecedented challenges of ever-changing and less predictable cities and the ever-growing expectations from clients and the general public [7], pose challenges for urban built environment professionals, such as urban designers, landscape architects, and architects.

These professions play a crucial role in achieving sustainability in cities and across society. They create urban fabrics that provide living environments for both human and non-human inhabitants, attract industries and stimulate economic activities, create public open spaces to foster social relationships, and optimize urban green infrastructure to promote healthy and sustainable lifestyles, to name a few [8–10]. To tackle the aforementioned growing challenges and complexities, sustainable proposals should be based on substantial scientific research and solid evidence. However, many practitioners in the urban built

environment professions lack research-based design skills; this is because professional educations do not traditionally involve these skills [11].

Under such circumstances, professional educations are crucial in effecting change, as they can prepare future practitioners [12]. Using an evidence-based design (EBD) approach would be a good method to enable students to rationally and scientifically address complex problems. This article presents a case study focusing on the implementation of EBD in an urban design studio for undergraduate students. The study examined the effectiveness of EBD in supporting the education process and outcomes. The findings shed light on professional education in urban built environment disciplines, which would further support the realization of the Sustainable Development Goals.

### 1.1. Concept and Evolution of the EBD Approach

The EBD approach has evolved from evidence-based medicine since the 1970s. This approach has been widely adopted in healthcare architecture and landscape design, particularly after Ulrich's landmark research regarding the positive impact of window views on patients' recovery and pain in 1984 [13,14]. However, a specific definition of the EBD method was not proposed until 2003, when D.K. Hamilton described it as "design work that is informed by data from a variety of sources" [15]. Hamilton states that credible research and project evaluations are crucial for evidence-based designers to make informed decisions. However, designers must also exercise caution when drawing inferences as such information may not always be a perfect fit for a project's unique situation [16]. In 2008, Hamilton and colleagues refined the definition as follows: "Evidence-based design is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project" [16].

Also in 2008, The Center for Health Design (CHD) defined EBD methodology as "The process of basing decisions about the built environment on credible research to achieve the best possible outcomes" [17]. EBD approaches differ from conventional designs by relying on credible evidence rather than norms or designers' personal experience [18]. The CHD also created a framework for the EBD process (see Figure 1). Although there are various versions of the EBD process [19,20], the CHD version is widely adopted and representative in demonstrating the fundamental workflow of the EBD method. In practice, healthcare design projects usually have clear goals and objectives at initiation, such as improving patient care experience, staff working environments, and organizational performance [16]. Based on these characteristics, the literature is critically collected and reviewed, and the evidence is filtered, selected, and translated into design decisions or proposals. By generating and testing hypotheses, defining metrics, measuring baselines, monitoring constructions, and conducting post-occupancy evaluations, the objectives can be assessed, and further actions can be taken if necessary [17]. According to its framework, EBD practices innately support the creation of proposals and projects that align with sustainable development agendas. During the design process, scientific and compelling evidence informs rational and rigorous decisions that then optimize the efficiency and effectiveness of source investments, eliminate trial-and-error costs through monitoring design implementation and construction, and optimize the long-term performance of the projects via post-occupancy evaluation (POE) [21].

According to the CHD, EBD approaches can be flexibly applied. A project may fully or partially incorporate the EBD process. According to the CHD's EDAC Advocate Brochures, only about 25% of recognized projects complete the entire EBD process. The majority of projects focus on the design phase, while a few concentrate solely on the evaluation phase [22]. The most common applications cover phases from defining goals and objectives to generate EBD concepts and proposals [22].

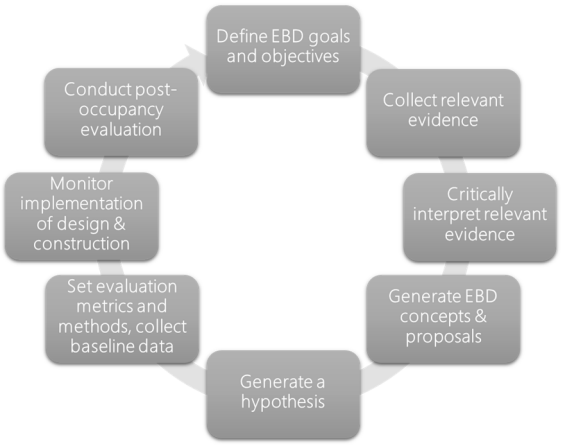



**Figure 1.** A typical EBD process (drawn by the author, based on the CHD's elaboration [17]).

EBD methods were originally developed for and mainly applied in healthcare designs, but they have also been applied in other project types, such as schools, resorts, animal housing habitats, and health systems [23,24]. However, it is important to note that not every project has specific and directly measurable objectives, meaning that the expected effectiveness of the proposals may not be defined as the hypothesis or tested quantitatively. This is more common for projects that involve human beings, natural environments, or urban fabrics, which are difficult, sometimes impossible, to be simplified into a few variables. Cooper-Marcus and Naomi [25] (p. 16) suggest a broader approach of "mixed methods" research, which engages many different sources of evidence and multiple methodologies (including qualitative and quantitative), resulting in more realistic and productive outcomes. The essential point is that there is no one-size-fits-all solution. EBD methods should be specific to both the site and the user.

Despite the clear framework of EBD approaches and the expectations of scientific quality in the design proposals, many practitioners struggle or lack the motivation to base their proposals on quality evidence. According to a survey in 2011, 72% of healthcare design practitioners claimed to apply an EBD approach, but many of them only did so as this was the norm or to fulfill regulation requirements [26]. Cortesão and Lenzholzer [27] found that designers commonly referred to precedents and personal experience when discussing research and design, rather than conducting original research or incorporating evidence from research. This is surprising given the increasing availability of open-access resources. One major reason for such limited application of EBD approaches is the insufficient training of practitioners. Many practitioners are not aware of the various types of evidence that can be applied, and lack the skills to effectively incorporate this evidence into their proposals [27]. Under such circumstances, it is critical to strengthen practitioners' awareness of EBD approaches and equip them with the necessary techniques to apply this awareness in practice. The best time to introduce EBD methodology is during professional education.

### *1.2. EBD Approaches in Studios of Built Environment Education*

Given the aforementioned challenges and emerging demands in the field, it is no longer sufficient to provide students in built environment disciplines with only conventional knowledge or skills [28]. It is beneficial for these students to acquire some scientific research frameworks that can facilitate and optimize their future practice. EBD methods are viable options as they outline the crucial and sequential steps for developing a rigorous proposal based on project-specific conditions, while also allowing for flexibility and innovation.

Despite the increasing demand for EBD approaches in professional environments, there are few publications or resources available to introduce EBD methodology to students in built environment disciplines. Additionally, EBD techniques are rarely utilized in the design studios that are recognized as the core of these disciplines [29]. So far, only a few studies have been conducted on evidence-based design studios [30–34]. EBD methods are

typically applied to architecture designs and interior designs at the building scale, with a focus on healthcare and senior projects [30,32–34]. For example, Pilosof and Grobman applied EBD approaches to an architectural studio in order to design the first Maggie's Center in Israel [33]. By reviewing research evidence on healthcare architecture design and existing Maggie's centers, utilizing EBD methodology enhanced students' awareness of the health impacts of architectural design, while also supporting their creative and innovative designs. Students found that the comparative analyses of existing Maggie's centers had the most significant impact on their designs. Lak and Aghamolaei published the only study to include EBD techniques in the construction of an urban design studio [31]. Their focus was on allowing students to learn and apply classical urban design-related theories in order to generate first-hand evidence for urban design proposal development. Specifically, they applied the Place-Check technique and Gehl's public life-tool. The students were trained to use a practical and participatory research approach, utilizing collected usage data to inform evidence-based designs. The efficiency of this approach was evaluated and confirmed based on the students' knowledge, skills, and attitudinal developments.

Urban design studios are commonly offered in major built environment professional programs, including architecture, urban planning, and landscape architecture. In these studios, urban design projects provide vital opportunities to prepare students for real-world practice, as suggested by Lang [35]. Such projects also integrate environmental, economic, and social issues in a comprehensive way which can establish a sustainable mentality among students. This is consistent with the underlying value of sustainability in EBD techniques [36]. Therefore, it is valuable to employ EBD approaches in urban design projects, and to investigate the contributions and effectiveness of EBD methods in preparing students to make rational and rigorous proposals, working towards a sustainable future of cities. The evaluation of the effectiveness of EBD practices should focus on optimizing decision making to achieve the stated common goals. It should also consider whether EBD techniques enable students in tackling complex urban issues and avoiding egocentricity or creating objects solely for admiration, rather than creating life-long habitats [35]. Furthermore, since professional education aims to prepare students for their future careers, it is important to examine the effectiveness of EBD methods from the perspectives of professional practitioners. However, there has been limited discussion regarding the effectiveness of EBD procedures from the urban design studios that adopt it. With these in mind, this study was conducted to introduce the theory and framework of evidence-based design (EBD) methodology to an undergraduate urban design studio, and investigate its effectiveness in facilitating teaching and learning. Special attention was paid to reveal how effectively EBD methods could influence decision making in critical design phases, from the perspectives of both the students and professional guests. The findings will contribute to the pedagogical development of urban design studios for professional education in built environment disciplines, enhance the strength of the relevant professions, and, ultimately, contribute to the sustainability of society.

## 2. Materials and Methods

This study investigates the implementation and effectiveness of EBD approaches across two rounds in the urban design studio for students in their third year of study on the undergraduate Landscape Architecture program at Tsinghua University. In the studio, a total of twelve students worked on two sites in 2022, and seven students worked on one site in 2023.

### *2.1. Delivering EBD Practice in the Urban Design Studio*

The urban design studio is the final studio in the third year of our landscape architecture undergraduate program. It is the final and most challenging studio in the urban context. In this studio, students need to comprehend the complex urban system, define site problems and identify site potentials, and develop corresponding proposals for sustainable industrial planning, urban fabric layout, urban image management, and social integration.

Special attention is paid to the organization of physical spaces, as they are the "containers" of urban life.

The studio spanned eight weeks, with two classes per week, each lasting 3.5 h. It followed a conventional three-phase structure, consisting of site analysis, design proposal development, and the final presentation. EBD methodology was integrated throughout the entire studio. In the first class, students were introduced to the EBD framework, receiving a studio brief and an introductory lecture on urban design. The second class consisted of a guided site visit. Afterward, students who worked on the same site collaborated to collect and analyze relevant site information. They also conducted thematic studies on critical issues they had identified. During the second phase, which spanned from the sixth to the fourteenth class, groups of three to four students defined design objectives and strategies based on their previous studies. They then developed urban design proposals which were supported by evidence, under the guidance of the tutor. Throughout this phase, the tutor consistently prompted students to demonstrate decision-making processes with evidence supporting their critical and major decisions. Based on real problems encountered in the studio, students became familiar with the concept and process of the EBD approach. They learned to proactively search for evidence, evaluate its quality, and apply it properly in order to support their proposal developments. In the final week, each group finalized and delivered their proposals for their final oral presentation and guest critiques. Upon completing the module, each student wrote a reflection on their experience of learning and applying EBD methods during the studio, as well as the perceived effectiveness of EBD practices.

Due to the limited time and resources within a single studio, it is impractical for students to complete the entire EBD process, from developing a comprehensive urban design proposal to the implementation and post-occupancy evaluation, within this timespan. Therefore, it is crucial to raise awareness of the EBD approach among students. This includes facilitating their understanding of key EBD methodologies and steps, as well as the mechanisms underlying complex systems, facilitating students to make rational and effective decisions [37]. To this end, a tailor-made EBD framework for design studio education was developed, as depicted in Figure 2. To maximize the application and contribution of EBD methods, this framework was developed using the conventional and widely applied design flow. The grey plates indicate where evidence is incorporated. In this way, EBD methods can enhance the conventional design flow, consolidating the results of each phase.

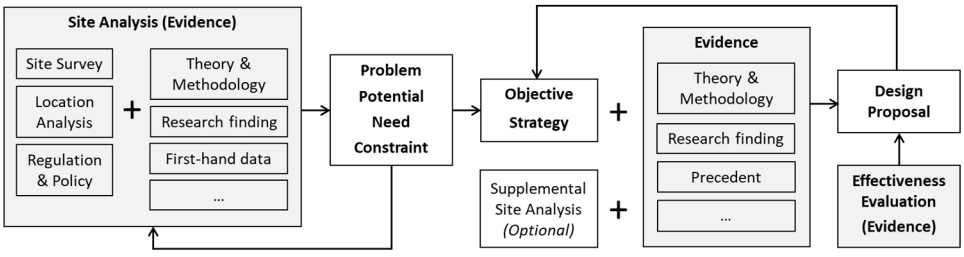



**Figure 2.** Modified EBD framework for design studio education (drawn by the author).

Among the three evidence-related plates, the first plate of site analysis serves two major purposes. One is to consolidate site analysis with data from multiple sources, including site surveys, stakeholder interviews, upper-level planning, government policies, regulations and legislations, guidelines, representative findings in research articles, theories, and methodologies that have been developed in the relevant fields. The other is to develop factual descriptions into in-depth and integral mechanism interpretations. This process identifies problems, possibilities, needs, and constraints that can be translated into urban design actions. It supports the generation of feasible design objectives and strategies. The second evidence-related plate is allocated in the process of design development. It facilitates creating solid and convincing design proposals involving the incorporation of

theories, methodologies, techniques, research findings, and precedents, rather than relying solely on designers' personal experience or preferences. This process of digesting and integrating various information is also where critical innovations may emerge. Finally, the effectiveness of design proposals must be evaluated. Although post-occupancy evaluation (POE) is highly recognized [38], alternatives can be useful for design proposals prior to implementation. In our study, we utilized computer simulations and expert evaluations. It is important to note that the process from site analysis to the design proposal is not always linear, as it involves back-and-forth deliberations and supplementary studies.

Across the last two rounds of studio delivery, three sites were selected (see Figure 3). These sites are located in historic areas of Beijing, China and have undergone development and evolution over several hundred years. The original Hutongs and traditional courtyards have been partially preserved, while some courtyards have been filled with small buildings or demolished for new developments. Conflicts often arise between the conservation of traditional city fabric and the development of new lifestyles and infrastructure, as well as between original residents and tenants. These conflicts highlight the need for urban renewal, presenting opportunities for engaging in EBD methodology.

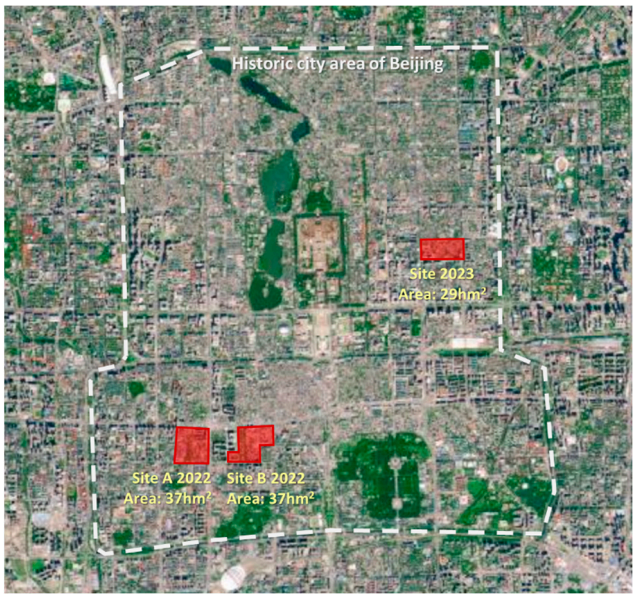



**Figure 3.** Locations and basic information of the three sites (drawn by the author, base map: Baidu map (https://map.baidu.com/ (accessed on 18 February 2024))).

### *2.2. Evaluating the Effectiveness of EBD Methods for the Urban Design Studio*

This study examined the effectiveness of EBD methods in facilitating the teaching and learning of urban design. Triangulation was used to ensure reliability by combining expected learning outcomes, student reflections, and external expert comments. Given the relatively small number of students and external experts involved in the urban design studios, qualitative semantic investigation was employed to provide in-depth interpretations. From the students' perspective, twelve module learning reflections were collected in 2022, and seven were collected in 2023. The reflections covered learning experiences including the difficulties encountered and the solutions, achievements, and lessons learned, as well as any contributions to the proposal development from EBD practices.

External experts were invited as guests to join our final presentation in each round and provide comments on the validity of students' deliveries. These guests had either professional or governmental experience that perfectly matched our design topics each year (see Table 1), while not being involved in the module development or the delivery of our studio. One week before the final presentation, the guests were provided with a brief introduction to the module's learning objectives, expected learning outcomes, pedagogy

with EBD methods, and site information. They were intentionally kept unaware of what the students would deliver until the final presentation. During the final presentation sessions, following any necessary clarification, the guests provided feedback on each group's drawing panels and oral presentations. Comments were based on the guests' knowledge and experience. On average, each guest spent approximately 20 min commenting on one group. Their comments on the students' learning outcomes indicated the effectiveness of EBD techniques from professional and practical perspectives.

**Table 1.** Basic information regarding the external guests who participated in final presentations.

| Year | Guest Label | Title and Affiliation | Specialty |
|---|---|---|---|
| 2022 | Guest 1 | Professor, School of Architecture, Tsinghua University | Over 30 years of experience in built environment education and practice; served as the module convenor and tutor of the urban design studio at the Department of Urban Planning; member of the Expert Advisory Group of the Beijing Municipal Committee for the Protection of Famous Historical and Cultural Cities; has presided over many urban design projects, including the renovation of Yandai Xiejie in the Beijing Shichahai Historical and Cultural Reserve. |
| | Guest 2 | Associate professor, School of Architecture, Tsinghua University | Over 20 years of experience in urban and landscape design practice and education; Deputy Head of the Department of Landscape Architecture, responsible for Teaching and Learning; research and practice largely focus on campus design and brownfield restoration. |
| | Guest 3 | Director of Landscape Architecture, AECOM (Beijing) | Over 20 years of experience in landscape and urban design practice; has presided over many urban renewal and urban open space projects, including the renewal of the Beijing Zhongguancun Street area. |
| 2023 | Guest 1 | Professor, School of Architecture, Tsinghua University | Same as the specialties of Guest 1 in 2022 |
| | Guest 4 | Partner and Vice President, ECOLAND | Over 20 years of experience in landscape and urban design practice both in China and overseas; has presided over numerous urban design and community planning projects, including the urban renewal and transformation of the Beijing Shougang Industrial Site, the Old West Gate urban renewal project in Changde, Hunan province. |
| | Guest 5 | Planner, Homedale Urban Planning & Architects CO., LTD of BICP | Has served as a responsible planner of Jianguomen Street (our site belonged to) for six years, conducting architecture evaluations and resident surveys. |
| | Guest 6 | Community Secretary of Kampar Street North | The local government officer of our site |

All content related to the EBD approach in the students' module reflections were extracted into a single Word document for each cohort. The comments and suggestions made by guests during the final presentation were voice-recorded and transcribed by year. This content was then coded using NVivo 11 to reveal key issues and relationships, and to further examine the effectiveness of EBD approaches in supporting urban design studio teaching and learning. The content was discussed anonymously with student names being replaced by a labeling format of S-Year (2 digit)-Number.

## 3. Results

### *3.1. Learning Process and Outcomes*

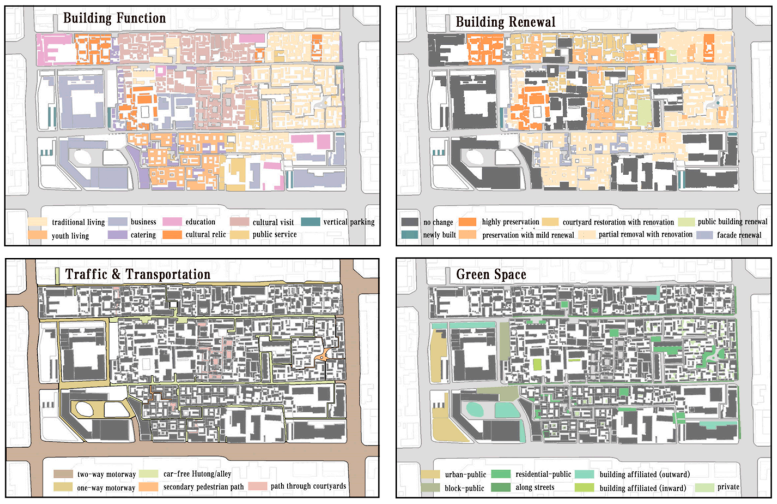
There were six groups in our urban design studio over the last two rounds. Each of them completed an urban design proposal. In this article, we use the work of one group to demonstrate how their critical design decisions were informed and supported by evidence (refer to Table 2 and Figure 4). This group of three worked on Site 2023 as shown in Figure 3. They began with a site survey and desktop studies. The site was found to have significant historic and cultural values. However, the overall living quality was poor. It suffered from worn architecture, insufficient greenery and catering facilities, the serious aging of original residents, and conflicts between user groups. Additional space was needed to address

these issues. When students searched for evidence to support their design objectives and strategies, they came across a policy of a voluntary surrender of tenancy. The policy aimed to encourage the vacancy and renovation of the traditional courtyards and introduce new business formats and public service facilities. The surrender rate of tenancy in a similar neighborhood adjacent to our site was as high as 80–90% [39], suggesting that the policy was feasible and promising. This policy and its success instilled great confidence in our students to propose a major strategy to relocate the original residents and renovate the unauthorized buildings.

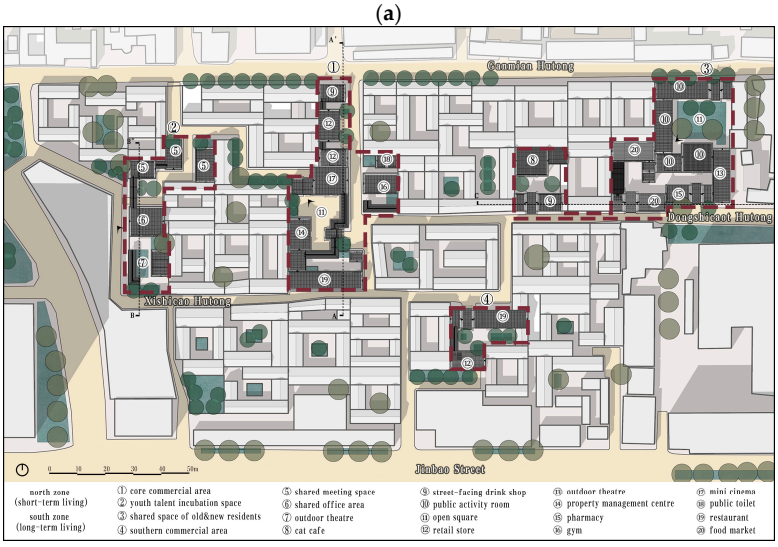
**Table 2.** Types of evidence engaged for the EBD of the demonstrated proposal.

| Major Decisions Be Made | Types of Evidence Engaged |
| --- | --- |
| Site problems, potentials, needs, constraints, objectives, and strategies | - Site surveys, observations, and analyses<br>- Documents about the history of the site: historic maps, annals, biographies<br>- Government documents: statistics, upper-level planning, policies and regulations<br>- Documents of similar projects<br>- Inputs of stakeholder interviews<br>- Academic publications |
| Design proposal development | - Inputs of stakeholder interviews<br>- Precedent practice (both cases and academic publications)<br>- Supplemental site surveys<br>- Computer modeling and simulation |

During the interim presentation which invited public participants, students had a lengthy discussion with the original residents and local government officers. The discussion confirmed the students' strategies and also provided insights into the expected composition of residents and the intended use of the space. Based on these inputs, the students revised their objectives and strategies. Aligning with the principles of sustainability, their objectives included the following: to improve the living conditions and quality of life for the original residents; to highlight the site-specific potential and value of history, traditional culture, and architecture; to introduce new business formats that agreed with Hutong culture; to create a system of "cultural heritage + space"; and to build a dynamic community that meets the needs of the future social structure. Accordingly, a scheme was developed to vacate and utilize historic and cultural courtyards to create a cultural visiting route that connected newly formed neighborhoods, as well as to supplement greening and public service facilities in the Hutong to improve the welfare of residents. As a result of the proposal, the residential area per capita doubled from 7–10 $m^2$ to 16–22 $m^2$, and the greening rate increased from less than 5% to 14% of the total site area. Additionally, catering and business options were added for both newly attracted young residents and the original residents (see Figure 4), promoting integration among residents and enhancing the overall vitality of the area.




(**a**)

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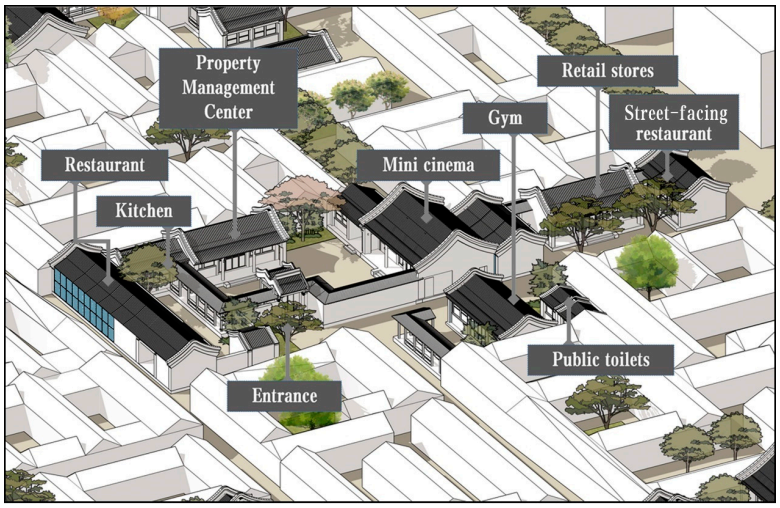


(**c**)

**Figure 4.** Studio deliveries demonstrating an EBD proposal (drawn by Zhangqian Ye, Ruiqi Li, Hongting Jia): (**a**) major aspects and solutions for the entire site; (**b**) a master plan of the youth rental area (southern part of the site; courtyards in white are rental areas for youth); (**c**) public service facilities in the youth rental area.

### 3.2. Students' Reflections

A total number of 18 nodes were coded based on EBD-related content in students' module reflections. The nodes were clustered according to word similarity using Jaccard's coefficient in NVivo, as shown in Figure 5. However, it is important to double-check the meanings of references under each node as the clustering was solely based on word similarity. As a result, a revised three-level node cluster emerged, which is presented in Table 3.

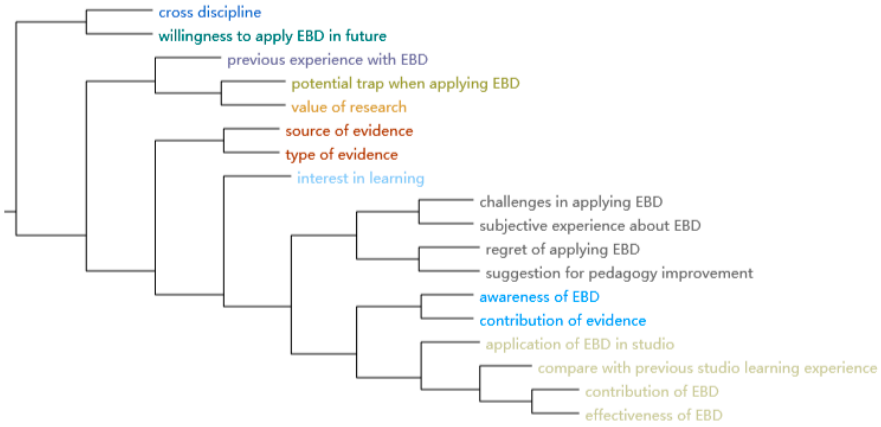


**Figure 5.** All nodes clustered by word similarity in NVivo (colorized 10 clusters by default derived from EBD-related parts in all students' module reflections).

**Table 3.** Node derived from EBD-related parts in all students' module reflections.

| Parent Node | Internal Node | Child Node | *N* of Coding References |
|---|---|---|---|
| Effectiveness of EBDs | Effectiveness of EBDs | Compare with previous studio learning experience | 11 |
| | | Application of EBDs in studio | 23 |
| | | Effectiveness of EBDs | 31 |
| | Contribution of EBDs | Awareness of EBDs | 8 |
| | | Contribution of EBDs | 20 |
| | | Contribution of evidence | 5 |
| | | Value of research | 6 |
| | Evidence | Source of evidence | 23 |
| | | Type of evidence | 34 |
| Learning experience of EBDs | Subjective experience with EBDs | Subjective experience with EBDs | 12 |
| | | Challenges in applying EBDs | 10 |
| | | Regret of applying EBDs | 9 |
| | | Suggestion for pedagogy improvement | 10 |
| | Interest | Interest in learning | 3 |
| | Impression of EBDs | Previous experience with EBDs | 3 |
| | | Potential trap when applying EBDs | 3 |
| Long-term impact of EBDs | Long-term impact of EBDs | Cross-discipline | 3 |
| | | Willingness to apply EBDs in the future | 2 |

Generally, most students had no prior knowledge of the EBD approach before enrolling in this studio. However, after learning and applying EBD methods throughout their studio work, all students found that this methodology contributed to their learning, guiding them to understand the site deeply and revealing inspiring references. These not only increased the students' productivity, but also boosted their confidence by delivering convincing proposals which were supported by evidence. According to the students, the most appreciated types of evidence were surveys of local people on site and relevant theories and methods that support node/thematic designs.

A word frequency analysis was performed on the 25 most frequently used words in all EBD-related student module reflections from both cohorts. The analysis only included words that had a minimum length of three letters and that matched exactly, using NVivo. The term "EBD" was mentioned 30 times, ranking third in frequency. A 3D cluster map was generated to display the four clusters for these top twenty-five words, as depicted in Figure 6. The diagram clusters words that co-occur and sizes the bubbles based on word frequency. The three most frequent words in the text are design, site, and EBD. Each of them forms a cluster of frequent words, indicating a close relationship within each cluster.

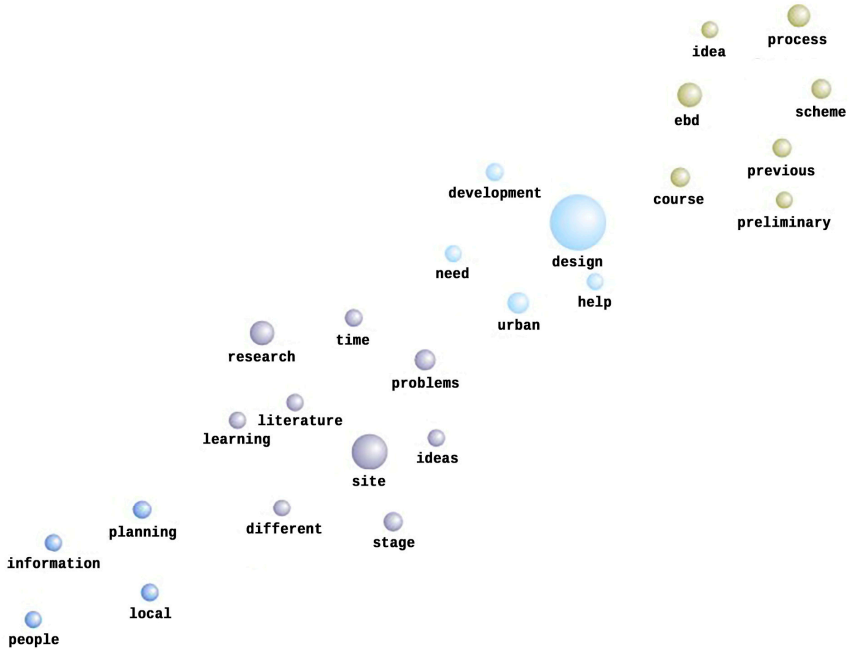


**Figure 6.** Four clusters of the twenty-five most frequent words in EBD-related content in all students' module reflections (displayed in lowercase).

### *3.3. Guests' Comments*

Overall, the guests who participated in our final presentations highly praised the students' achievements in addressing complex urban design problems and needs. They appreciated the students' abilities to extract critical information from large amounts of data through the use of various methods and instruments, innovatively transform site survey findings into evidence-based design proposals, and use unconventional visualization methods to deliver non-spatial and people-oriented proposals.

The comments of experienced educators and practitioners who attended as guests were deemed representative of current common concerns and methodologies related to urban design. Table 4 shows the 40 most frequently used words that were extracted from the transcriptions of guests' comments in the last two rounds. The concepts of "design" and "space" are the most prominent concerns, followed by "location" and "problem". These are common issues in almost all types of built environment design and planning works [40]. Additionally, the term "analysis" is mentioned 50 times, while "research" is only mentioned 20 times. Notably, the term "evidence-based" was only mentioned twice in 2022 and three times in 2023 by the guests, suggesting that the guests were not accustomed to applying EBD methods in their practice. Therefore, the comments and suggestions of guests are crucial in identifying areas where EBD approaches could make the most significant contributions to real-world practices.

**Table 4.** Results of the 40 most frequent words in all guests' comments.

| Word | Count | Weighted Percentage (%) | Word | Count | Weighted Percentage (%) |
|---|---|---|---|---|---|
| design | 191 | 1.82 | building | 24 | 0.23 |
| space | 163 | 1.55 | traffic | 24 | 0.23 |
| location | 93 | 0.89 | landscape | 24 | 0.23 |
| problem | 90 | 0.86 | open | 24 | 0.23 |
| city | 77 | 0.73 | population | 23 | 0.22 |
| analysis | 53 | 0.5 | function | 22 | 0.21 |
| block | 42 | 0.4 | node | 22 | 0.21 |
| site | 38 | 0.36 | resident | 22 | 0.21 |
| history | 38 | 0.36 | conflict | 22 | 0.21 |
| culture | 37 | 0.35 | status quo | 22 | 0.21 |
| presentation | 36 | 0.34 | planning | 21 | 0.2 |
| life | 36 | 0.34 | process | 21 | 0.2 |
| renewal | 34 | 0.32 | value | 21 | 0.2 |
| relationship | 34 | 0.32 | conservation | 20 | 0.19 |
| Hutong | 31 | 0.3 | public | 20 | 0.19 |
| district | 30 | 0.29 | research | 20 | 0.19 |
| proposal | 29 | 0.28 | influence | 20 | 0.19 |
| place | 25 | 0.24 | yard | 20 | 0.19 |
| community | 25 | 0.24 | renovation | 19 | 0.18 |
| surrounding | 25 | 0.24 | concept | 19 | 0.18 |

It was found that guests were primarily concerned with the premises, development, and effectiveness of the proposals. These findings suggest areas of focus for professional education with incorporating the EBD approach. To identify specific aspects that could be supported by EBD techniques during professional practice, the comments and suggestions provided by all guests during final presentations were further coded in NVivo. The coding process was primarily deductive, except for the emergence of a fourth theme, "optimize learning through EBD". The coding results are presented in Figure 7.

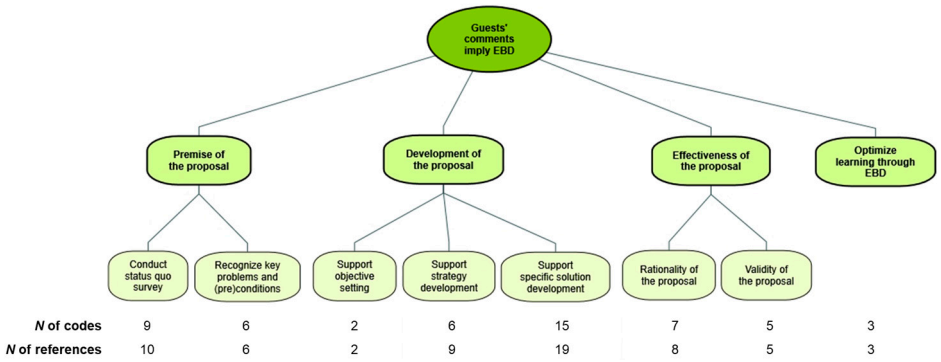


**Figure 7.** Thematic coding of guests' comments that imply EBD methodology.

## 4. Discussion

### *4.1. Effectiveness of EBD Methodology*

According to the students' module reflections, they were able to make steady progress in proposal development without much confusion due to the assistance of EBD approaches during the learning process. One student (S-22-4) commented that the design process was very effective, and there was rarely repeated work. Students also reported experiencing improvements in design methodologies compared to previous studios. They were able to work efficiently on urban design, despite its complexity when compared to previous design topics: "*The scheme's scientific and logical aspects had been significantly improved compared to previous designs*" (S-23-2); "*after conducting numerous site visits and community interviews, the design's feasibility and professional responsibility were more impactful than any previous proposals that emphasized on form and basic design skills training*" (S-23-4). Students' confidence in their

proposals was bolstered by making evidence-based decisions: "*EBD played a crucial role in this design. It enabled us to create a comprehensive and defensible design scheme based on evidence and relevant theories or preliminary analyses, from knowing nothing about urban design*" (S-22-3). Figure 6 further demonstrates the close relationship between EBD methodology and terms such as process, scheme, previous, course, idea, and preliminary. In the reflections, these words appear together mainly to compare this studio with previous ones, comment on the general settings and achievements of this studio, as well as the application and effectiveness of EBD methods.

As previously stated, guests placed great emphasis on the premises, development, and effectiveness of the proposal (Figure 7). These three aspects are crucial anchor points that connect education and practice for EBD application; therefore, they serve as the basis for the following discussions.

#### 4.1.1. Premises of the Proposal

The premises of the proposal are mainly derived from the phase of site analysis in our urban design studio, which primarily aims to establish appropriate objectives and strategies for the project. Unlike typical EBD applications for healthcare facility design projects, which usually have clear and specific objectives from the onset, such as specific healthcare experience or outcomes, urban design is complex, and objectives defined from different perspectives would all be valid. Therefore, site analysis (see Figure 2) is pivotal for urban design to establish specific objectives to be attained and examined. For renewal projects, it is similar to the phase of "conduct post-occupancy evaluation" shown in Figure 1.

During this phase, students need to gain a comprehensive and deep understanding of the site. The target is similar to conventional practices [41]. Thanks to the increased accessibility of rich resources, students can now collect relevant information on upper-level planning and regulations, history, statistics on population, economy, infrastructure, natural and cultural elements, research publications, and practice precedents. However, undergraduate students with limited life and working experience face challenges in filtering information, prioritizing identified issues, analyzing various data, and extracting critical problems, needs, possibilities, and mechanisms. This phase is vital for the positioning of design proposals. It also important for students to become familiar with different types of evidence that they will further explore in later phases. The importance of this phase was appreciated by the students.

> *"The method of EBD requires the development of the scheme be based on sufficient research on the status quo and literature, . . . which provides a powerful basis for controlling the renewal design of an old city area with a complex historical and cultural background."*
>
> (S-22-7)

> *". . . the analysis of practical problems and the literature search for solutions enabled us to carry out the design in a down-to-earth manner, such as extracting on-site POI data and calculating the population."*
>
> (S-22-1)

> *"During the first two weeks, it became clear that we must fully grasp enough site information to cope with various complex issues that emerged and identify the potential of different designs."*
>
> (S-23-6)

According to the guests, collecting, critically examining, and integrating various data is vital for the understanding of the site. As Guest 1 stated, "*Urban design has two important aspects: One is to identify and carry forward the most valuable things on the site. . . The other is to identify and tackle the problems of the site*". Guest 1 continues, stating that "*We need to be good at recognizing and establishing connections between certain issues or concepts based on their intrinsic essence*".

One noteworthy point of this phase is that, among all the types of evidence collected, students found direct interviews and communications with stakeholders to be the most helpful. In our experience, relying solely on objective information can lead to valid but often insufficient conclusions regarding specific site conditions, which can hinder further proposal development. Direct communication with local stakeholders enables students to understand not only site-specific phenomena, but also the underlying reasons and mechanisms. Such effects were demonstrated by the two cohorts' different experiences.

In 2022, a COVID-19 pandemic lockdown affected our studio delivery from the second week. As a result, this cohort of students had limited opportunities to approach stakeholders after gaining a general understanding of the site through desktop studies. The only exploratory interviews conducted during our guided site visit in the first week were quite general, and thus were not very helpful for the following design work. In 2023, students were free to visit the site as much as they liked. After receiving an introduction to interview techniques and tips, one of the two groups conducted on-site interviews spontaneously. This triggered empathy among the students for the site and the potential users, which further stimulated great progress. The students even described the shift in their design after interviewing local people as "*a leap*" (S-23-5), claiming that "*the site became alive in our minds" (S-23-6)*.

According to these students, nonverbal cues, such as tones, facial expressions, and gestures, during interviews conveyed a significant amount of information and emotions from stakeholders with years and even lifelong on-site experience. This was highly impressive and helped the students to connect with the site and its inhabitants, thus providing valuable support for independent and proactive thinking. Such insights are unattainable via desktop studies or simple site visits. Direct cognitive impressions can be mind-opening, inspiring, and highly effective in cultivating empathy [42]. This is considered critical for responsive design proposals [43]. Close attention to local people and future users was also appreciated by guests. As Guest 3 stated, "*Before, we [urban designers] discussed more on paper and with decision makers; but now and in the future, we must pay much attention to actual users, and get involved with them, to deliver practical solutions and proposals for these people*".

#### 4.1.2. Development of the Proposal

In general, most students found the EBD approach to be helpful and effective for their proposal development, as it contributed in three main ways. Firstly, it supports innovations with theories and methodologies. Commonly, students want to make their proposals "look different/ bold". When they raise any "big idea" for their proposals, EBD methodology helps students to justify their proposals by demonstrating their relevance to the design objectives. During the process of clarification and evidence gathering, students discovered numerous design theories and methodologies. Learning and applying these proved to be more effective when tackling design problems and meeting objectives than relying on arbitrary innovations. As one student noted, "*EBD is indeed helpful for generating design ideas*" (S-23-1). The compatibility between theories and innovations was also confirmed by guests: "*Each student researched their node/special design topic. This is commendable. . . .Reading literature to learn theories and methods has a significant impact on the design process*" (Guest 1).

Secondly, EBD methods promote a continuously deepened understanding of the site and aid in decision making. This effectively supports challenging cases such as conflicts between development and conservation, as noted by Guest 2. In our urban design studios, first-hand data collection from site surveys continues until the very late stages. For instance, in 2023, the interim presentation was held on-site and local officers and residents were invited. Our students engaged in a discussion with local people to clarify preconditions for their proposals. This led to a dramatic shift in the major strategies and solutions presented in Section 3.1. Students' proposals were continuously improved as they collected more evidence and gained a deeper understanding of the site, as reflected by S-23-5: "*With the support of a significant amount of evidence, some design details required further confirmation or adjustment*". According to S-23-6, during the design stage, the EBD approach helped to

clarify design ideas, from the problems faced to the objectives, principles, and solutions. Guest 4 also acknowledged the clear structures and logic behind students' proposals.

Thirdly, EBD methodology supports self-study capacity building for proposal development. It is crucial to note that students will eventually have to execute their own design decisions. To encourage students to work out their proposals independently, the tutor's primary role was to probe for design justifications and provide evidence hints, rather than providing solutions or making decisions for students. Students continuously seek evidence to develop and justify their proposals from the scope of the master plan to that of the node/special design. They need to generate proposals based on in-depth analyses and rational judgments. This leads to a natural evolution in the depth of their proposals. It also leads to a greater sense of control and achievement for students, ultimately resulting in more meaningful learning experiences and improved learning outcomes [44].

One important aspect to consider is that, as students continue to collect data and evidence, their original site analyses, design objectives, and strategies need to be reviewed and may be continuously adjusted. Students were aware of this: "*It is essential to review and revisit the site throughout the entire design cycle. It is also crucial to clarify and promptly confirm the problems and objectives*" (S-23-4). Therefore, the EBD method is not a linear one-way process, but rather involves a lot of back-and-forth efforts. There may not be a clear-cut line between design phases, as different phases may overlap to a certain extent.

#### 4.1.3. Effectiveness of the Proposal

According to the EBD framework, the effectiveness of a proposal is examined by measuring the changes made following implementation, and is checked against the design objectives and goals. Although it was infeasible to implement students' proposals in our case, students were encouraged to evaluate their proposals with modeling and simulation techniques [45]. The effectiveness of the students' proposals was also evaluated by guest critics.

In 2023, a group utilized space syntax theory [46,47] (pp. 223–241) and the software Depthmap 10 in order to conduct computer simulations. They aimed to compare different design scenarios and demonstrate the effects of spatial connectivity before and after road system modification. The results showed that their final proposal improved the integration of the road system and increased the mean value by 9.1% (Table 5), which greatly improved the accessibility of the neighborhood [48]. In 2022, a group utilized ArcGIS spatial analysis to assess the effectiveness of their proposal in improving the public space system (Figure 8). Significant improvements were achieved by reopening buildings and courtyards that were previously owned by provincial or county guilds to the public, as well as creating public open spaces by demolishing illegal buildings. Besides Depthmap and ArcGIS, students also used Rhino and Ladybug to analyze microclimates and inform design decisions. Simulations quantified and visualized the effects of design proposals, making the decision-making process more scientific and convincing. As S-22-5 stated, "*In the final presentation, I felt that my design had stronger support, rather than being a complete fantasy*".

**Table 5.** Effectiveness of road system modification (Road integration analyses in Depthmap, examined by Wei Lin in 2023).

| Indicators of Road Integration | Status Quo | Design Proposal | Δ |
|---|---|---|---|
| Mean | 1.214 | 1.324 | 9.1% |
| Min | 0.333 | 0.333 | 0% |
| Max | 2.589 | 2.830 | 9.3% |
| SD | 0.543 | 0.560 | -- |

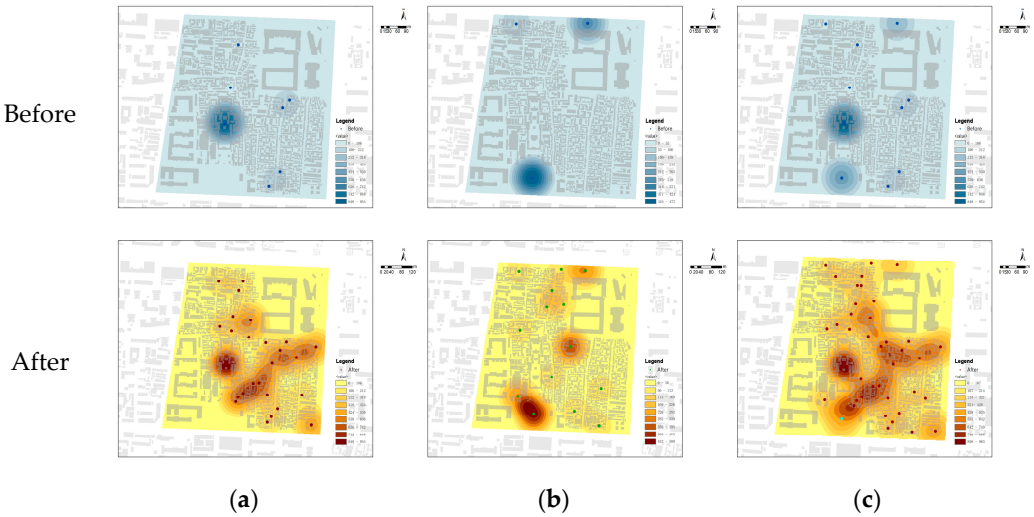


**Figure 8.** Public space distribution improved by the design proposal (based on ArcGIS analyses, generated by Xuehan Wang, Yao Qu, and Yushu Zhang in 2022): (**a**) building and courtyard; (**b**) open space; (**c**) integrated.

During the final presentation session, external guests evaluated the effectiveness of the EBD approach and provided feedback on the students' oral and drawing panel presentations. The proposed site problems, potentials, and design objectives were highly recognized by all guests for most groups. This confirmed the effectiveness of EBD methods for site analysis and objective definition. Based on guests' feedback, half of the groups each year delivered proposals that exceeded guests' expectations, with most solutions being valid. The remaining groups delivered valid major solutions that contained certain flaws in some node/special design solutions. This was mainly due to the limited time in the studio. Overall, guests considered the EBD approach to be supportive in ensuring favorable teaching and learning outcomes in our urban design studio.

Based on the above results and discussions, guests' concerns regarding the proposal's premises, development, and effectiveness correspond with the three grey plates that incorporate evidence in our proposed EBD framework for the design studio (Figure 2). This indicates that our EBD framework is well-suited for real-world practical concerns, thereby bridging professional education and practice.

### *4.2. Long-Term Impacts*

The challenges faced by built environment professionals have become increasingly complex. When applying EBD methodology, students can interpret and integrate evidence from the literature, precedential cases, and first-hand information in order to analyze problems, needs, and possibilities from multiple perspectives. This training helps students to understand and convert research methods and findings across disciplines through exposing them to the scientific language adopted in different fields. This can address the shortcomings of insufficient rationale and derivation processes in landscape architecture, which is rooted in the beaux-arts model and emphasizes visual quality, individual creativity, and originality [49]. Familiarizing students with multiple perspectives can broaden their horizons and expand their thinking dimensions [50]. This allows students to see resources and potential ways of integration for informed and sustainable design solutions that they were previously unaware of. Furthermore, it can foster an interdisciplinary mentality by highlighting potential disciplines for collaboration and opportunities for action [28,51]. This responds to students' needs for cross-disciplinary support when facing comprehensive design problems as reflected in their module reflections, and would ultimately influence students' long-term career development [32]. Additionally, several students expressed their interest in applying EBD approaches in the future.

### *4.3. Limitations, Suggestions, and Future Research*

Due to the small class sizes of twelve and seven students across the two rounds of evidence-based urban design studios, discussions on the effectiveness of EBD methods are mainly qualitative. However, small class sizes allow for close observations, as well as timely and in-depth communications between the tutor and students. The tutor was able to respond to each student's problems and facilitate their progress by clarifying issues, providing references, or suggesting directions. Nevertheless, quantitative and qualitative analyses can be applied together for more comprehensive research, particularly when large numbers of students or broad applications are available.

Confined by the timeframe of our urban design studio, it is not feasible to implement the entire process of the EBD approach. This limits EBD applications in professional education and practice. If possible, it is recommended to extend the timeframe of one studio to cover more phases of EBD methodology. This will allow some buffer for back-and-forth discussions of the design proposal. Alternatively, at the program level, a series of modules could be arranged, each focusing on a certain portion or aspect of EBD techniques. In addition, the EBD approach can be applied to studios that focus on different types and scales of projects. These will help students to acquire a reinforced and more comprehensive understanding and experience of EBD practices.

Pedagogically, the primary objective of our evidence-based urban design studio is to instill in students the mindset and skills necessary to apply EBD methods via the process of developing an urban design proposal. As students have limited experience in urban design and EBD methods, it is important to provide them with encouragement and close guidance in order to apply EBD methodology and focus on major issues. This helps students accumulate experience and deepen their understanding of the EBD approach, while avoiding getting delayed by details early in the process. It is also important to push analyses from factual summaries to reveal hidden mechanisms or relationships and arrive at more innovative solutions. Furthermore, it is important to help students think pragmatically and reflectively [52] by encouraging and facilitating them to make design decisions that are based on evidence. This could be challenging for tutors, as they need to be highly sensitive to students' needs and problems, and respond appropriately and promptly. More research is needed to accumulate experience in applying EBD approaches in different situations, examine its effectiveness, summarize the challenges and principles of implementation, as well as support for tutors.

## 5. Conclusions

This study proposes a non-linear EBD framework for built environment design education and investigates its validity and effectiveness over two rounds of urban design studio in an undergraduate Landscape Architecture program. It confirms that EBD methodology facilitates teaching and learning, and enables students to grasp complicated new knowledge and skills within a tight timeframe. The EBD approach also prompts innovative and defensible design proposals that consider the sustainability of cities, foster continuous self-study, and help students to progress rationally and confidently. The effectiveness and long-term impacts of EBD methods have been demonstrated by students' learning outcomes and reflections, as well as by external guests' comments. When integrated with conventional practice, the EBD approach meets the expectations of professional practice by effectively contributing to the premises, development, and effectiveness of the proposals. EBD framework, together with relevant professional practice, can support education for built environment disciplines, including urban design, landscape architecture, and architecture.

To achieve good EBD outcomes, it is important not only to have direct and in-depth communications with stakeholders, but also to utilize a variety of evidence, such as government documents and regulations, statistics, academic publications, theories, methodologies, computer programs, and AI techniques. These foster cross-disciplinary collaborations, reduce barriers, and increase the feasibility of applying EBD approaches in practice, partic-

ularly for complex project types. EBD methodology can also contribute to students' future studies, career development, and even the evolution of built environment professions. Finally, making informed design decisions based on valid and reliable evidence can reduce or even eliminate trial-and-error costs in projects, achieve desired design outcomes, and contribute to sustainable development.

Last but not least, it should be noted that due to the limited number of students in our urban design studios, this study does not cover all potential issues related to the application of EBD methods. Future studies are encouraged to expand the scope and scale of EBD pedagogy in built environment professional education.

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