

Article

Transformation and Revitalization of Industrial Heritage Based on Evidence-Based Approach for Emotional Arousal: A Case Study of Siwangzhang Patriotic Education Base, Guangdong

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Abstract

In the context of industrial heritage conservation and adaptive reuse, the transformation of industrial buildings into patriotic education bases has emerged as a significant approach, where enhancing emotional education efficacy becomes crucial. This study adopts an evidence-based design (EBD) methodology, focusing on the Siwangzhang patriotic education base in Guangdong Province, to address the scientific evaluation and optimization of emotional arousal efficacy. The research rigorously follows the standardized EBD workflow: (1) during problem definition, the literature review establishes the dual objectives of quantitative assessment and spatial optimization; (2) evidence collection employs questionnaire surveys to capture emotional data from both static environmental nodes and dynamic activity nodes; (3) evidence analysis integrates descriptive analysis, factor analysis, emotional mapping visualization, and paired-sample *t*-tests. Key findings reveal the following: (1) spatial emotional distribution exhibits three distinct patterns—high-arousal clusters, single-node prominence areas, and emotional depressions; (2) dynamic training activities significantly enhance 66.7% of observed emotional variables. A seven-stage progressive training protocol was developed to achieve phased emotional cultivation. This study validates the applicability of EBD methodology in educational space optimization through a complete workflow, establishing an operational evaluation framework integrating spatial-behavioral-emotional metrics. It provides empirical evidence for targeted optimization of patriotic education bases while pioneering a data-driven transition from conventional experiential design. The results hold theoretical and practical significance for revitalizing industrial heritage through socially valuable functional transformations.



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Keywords: evidence-based design; industrial heritage; patriotic education base; emotional evaluation; spatial optimization

1. Introduction

Industrial heritage serves as a vital testament to industrial civilization, embodying historical, social, technological, and esthetic values that carry an indispensable part of urban cultural memory [1,2]. Amidst rapid global urbanization, the preservation and adaptive reuse of industrial heritage have become pivotal challenges in the context of urban renewal [3,4]. Industrial heritage typically comprises tangible relics from the industrial

period—such as buildings, facilities, machinery, technical expertise, as well as intangible social memories [4,5]. The successful revitalization of these sites necessitates a systematic assessment of their historical, cultural, and technological significance [6,7], and requires the integration of their spatial characteristics with the broader needs of regional development [8,9], thereby achieving a balance between preservation and contemporary utility.

Specifically, the adaptive reuse of industrial heritage generally follows four predominant typologies: cultural-creative districts that revitalize spaces through artistic functions [9,10]; urban public spaces that transform industrial sites into civic amenities [11]; commercial tourism complexes that reactivate economic value [12,13]; and educational facilities that confer new social functions [14,15]. Among these pathways, educational bases have emerged as an important place due to their social cultivation potential. As a special category, patriotic education based on industrial heritage plays an irreplaceable role in fostering national identity and collective memory [16]. Under the framework of China's "National Defense Education" policy, the conversion of industrial sites for educational purposes has expanded substantially; however, the educational effectiveness of these initiatives varies widely. Existing designs predominantly adopt empirical methods [2], with a distinct lack of quantitative analysis concerning the "space–behavior–emotion" interaction mechanism. This shortage of assessment tools has left most educational bases trapped in a paradox of high investment but low effectiveness.

To address these challenges, existing studies propose partial solutions from two dimensions. In the field of industrial heritage, Zhou et al. [17] quantified the relationship between function and user through structural equation modeling (SEM), and established connections between design and emotion in virtual environments. Fang et al. [18] utilized path analysis to compare the "built environment–satisfaction" and "visitor participation–satisfaction" pathways, thereby revealing the "behavior–emotion" mechanism in physical contexts. In research on educational bases, particularly those focused on red tourism sites. Red tourism, as a contemporary Chinese form of heritage tourism, refers to themed tourism activities involving learning, sightseeing, and nostalgia in communist heritage sites, which commemorate past revolutionary events, heroes, and leaders [19]. It not only serves as a significant driving force for tourism economic development but is also commonly utilized by the government as an ideological tool to convey values and social norms [20,21]. As a type of spatial carrier with clear educational attributes, the emotional arousal of red tourism bases have garnered sustained academic attention. Zhou et al. [22] applied the Stimulus–Organism–Response (SOR) theory to illustrate how red tourism promotes well-being by eliciting emotional arousal and reinforcing national identity. Sun and Lv [23] highlighted the role of physiological experiences in collective identity formation within "dark tourism" sites, while Zhou et al. [24] identified the positive effect of national capability on memorable experiences using PLS-SEM. Although these studies have deepened our understanding of individual dimensions, none have yet provided a holistic, quantitative analysis of the tripartite "space–activity–emotion" activation mechanism.

To bridge this gap, this study introduces evidence-based design (EBD) methodology. Through its "evidence–decision" mechanism, EBD systematically quantifies patterns of patriotism arousal within repurposed industrial heritage spaces by integrating multi-source data [25], thus providing scientifically grounded optimization guidelines. This research focuses on the Siwangzhang Patriotism Education Base—a converted mining heritage site in Guangdong—and establishes a "space–behavior–emotion" model to evaluate the site's capacity for emotional arousal. The assessment employs a range of methodologies, including principal component analysis (PCA), emotional mapping visualization, and paired-sample *t*-tests. Based on these findings, a seven-day progressive training protocol is developed, offering data-driven solutions for the optimization of spatial and activity design.

This research makes some primary contributions. First, it shifts the design of education bases from empirical approaches to an evidence-based paradigm through the implementation of quantifiable emotion mapping. Second, it demonstrates the applicability of evidence-based design (EBD) in optimizing patriotic spaces by establishing a comprehensive verification workflow. Moreover, the study presents an empirically validated pathway for improving the effectiveness of patriotic education. Furthermore, it offers a replicable methodology and empirical example for the functional transformation and value enhancement of industrial heritage sites, thereby achieving the dual goals of elevating educational outcomes and preserving heritage significance.

2. Literature Review

Evidence-based design (EBD) theory originated from early speculation about the therapeutic effects of healthcare environments, emerging in the wake of the shift from traditional to evidence-based medicine [26]. Unlike conventional design methods, EBD employs a scientific, cyclical “research–design–research” process [27], in which evaluation and feedback inform subsequent iterations. This approach makes both the design process and its outcomes more scientifically rigorous. The origin of EBD is widely attributed to Ulrich’s seminal study, which demonstrated that window views to natural environments positively influenced postoperative patient recovery [28,29]. EBD’s theoretical basis developed progressively, and Ulrich formally introduced the “Supportive Design Theory” in 1991, emphasizing strategies for healthcare facility design aimed at reducing patient stress. Hamilton formally defined EBD in 2004 [26] and further refined it in 2009, coinciding with The Center for Health Design (CHD) launching the Evidence-Based Design Accreditation and Certification (EDAC) program to credential professionals in the field [27,30].

During the refinement of theoretical frameworks, EBD principles progressively integrated into the practice of medical architecture, with the overarching objective of enhancing therapeutic efficacy through optimized environmental interventions. In psychiatric hospitals, Bodryzlova et al. [31] demonstrated how specific architectural features reduced patient stress and fostered social interaction, thereby providing a theoretical basis for mental health facility renovations. For ICU design, Hamilton et al. [32] issued guidelines that strongly advocated for high-visibility layouts, natural lighting, and flexible spatial configurations to accommodate emergencies, thus establishing concrete standards for both new constructions and retrofit projects. Pediatric research by Bock et al. [33] systematically showed that child-centered designs alleviate anxiety, while Read and Meath’s sustainable EBD framework [34] highlighted the synergistic benefits between indoor environmental quality and energy systems, supporting the development of green hospitals. Trochelman et al. [35], examining cardiac specialty facilities, found that humanized design elements—especially privacy zones and natural lighting—contributed to significantly increased patient satisfaction in pre-intervention and post-intervention comparisons. Innovatively, Shultz and Jha [36] employed VR simulations to validate improvements in pharmacy design, demonstrating the predictive utility of virtual environments for workflow outcomes. Collectively, these studies underscore the potential of EBD to optimize healthcare architecture across therapeutic, experiential, and sustainability dimensions through scientifically validated strategies.

As related methodologies matured, EBD applications expanded across building typologies, demonstrating its potential to systematically integrate empirical research with design practice. In the realm of urban public spaces, Charras et al. [37] proposed six landscape dimensions for Alzheimer’s gardens, constructing a therapeutic framework promoting autonomous behaviors. Landscape studies comparing post-occupancy evaluation (POE), sustainable sites initiative (SITES), and landscape performance series (LPS) systems [38] traced the progression of landscape performance evaluation—from mere benefit descrip-

tions to causal investigations into ‘design strategy-actual benefit’ relationships. Within long-term care facilities for individuals with intellectual disabilities, Vollmer et al. [39] verified, through mixed-methods research, four design criteria that effectively enhance temporal perception, thereby offering spatial paradigms suited to high-dependency populations. In the educational sector, empirical studies have confirmed that the integration of natural elements within school environments can significantly improve health metrics among teachers and students [40], thus providing cognitive and psychological optimization frameworks for school planning. Davoodi et al. [41], focusing on office environments, established quantifiable lighting standards through the EBD-SIM (evidence-based design, simulation) framework, verifying the correlations between visual comfort metrics and subjective human perception. Collectively, these cases illustrate that EBD offers targeted spatial optimization strategies for a variety of building types by establishing robust empirical linkages between spatial variables and performance outcomes.

The core strength of EBD lies in its scientific rigor and systematic approach, which enable the establishment of verifiable correlations between built environments and users’ behavioral responses. Accordingly, this study employs the EBD methodology to develop a quantitative “space-behavior-emotion” evaluation model for patriotic education bases, thereby providing empirical support for advancing these sites from function-oriented to emotion-driven design paradigms.

In examining the emotional arousal mechanisms of industrial heritage repurposed as patriotic education bases, there is an urgent need to establish a systematic emotional assessment framework to address the critical gap in quantitative measurement tools. Through a systematic literature review, this study identifies six core emotional dimensions: identity, pride, awe, belonging, responsibility, and security. This selection not only responds to evidence-based design’s requirement for measurable evidence but also provides theoretical foundations for constructing the “space-behavior-emotion” quantitative model.

Identity, as the foundational dimension, establishes individual-nation connections through institutional recognition, with red tourism studies confirming its efficacy in strengthening national identity cognition [16]. Pride, deriving from both material achievements and spiritual traditions [42], serves as the direct motivator for patriotic behaviors. Awe, operationalized through sacred space experiences and historical narratives, has been demonstrated to facilitate collective memory transmission in dark tourism contexts [25]. Belonging emerges from cultural symbol interactions [43], with urban landscape research showing its capacity to enhance place attachment [44]. Security, rooted in embodied experiences of national defense capabilities, shows significant correlations with environmental design [37]. Responsibility is theorized as the critical nexus transforming emotional cognition into actionable commitments, addressing the “knowing-doing gap” in patriotic education.

Collectively, this emotional framework captures both individual psychological responses and collective value identification, offering measurable indicators for subsequent empirical investigations.

3. Research Methodology

This study adopts a comprehensive EBD framework comprising four progressive phases: problem definition, evidence collection, evidence analysis, and solution optimization. The technical workflow systematically integrates quantitative approaches to investigate emotional arousal mechanisms in patriotic education bases, as shown in Figure 1.

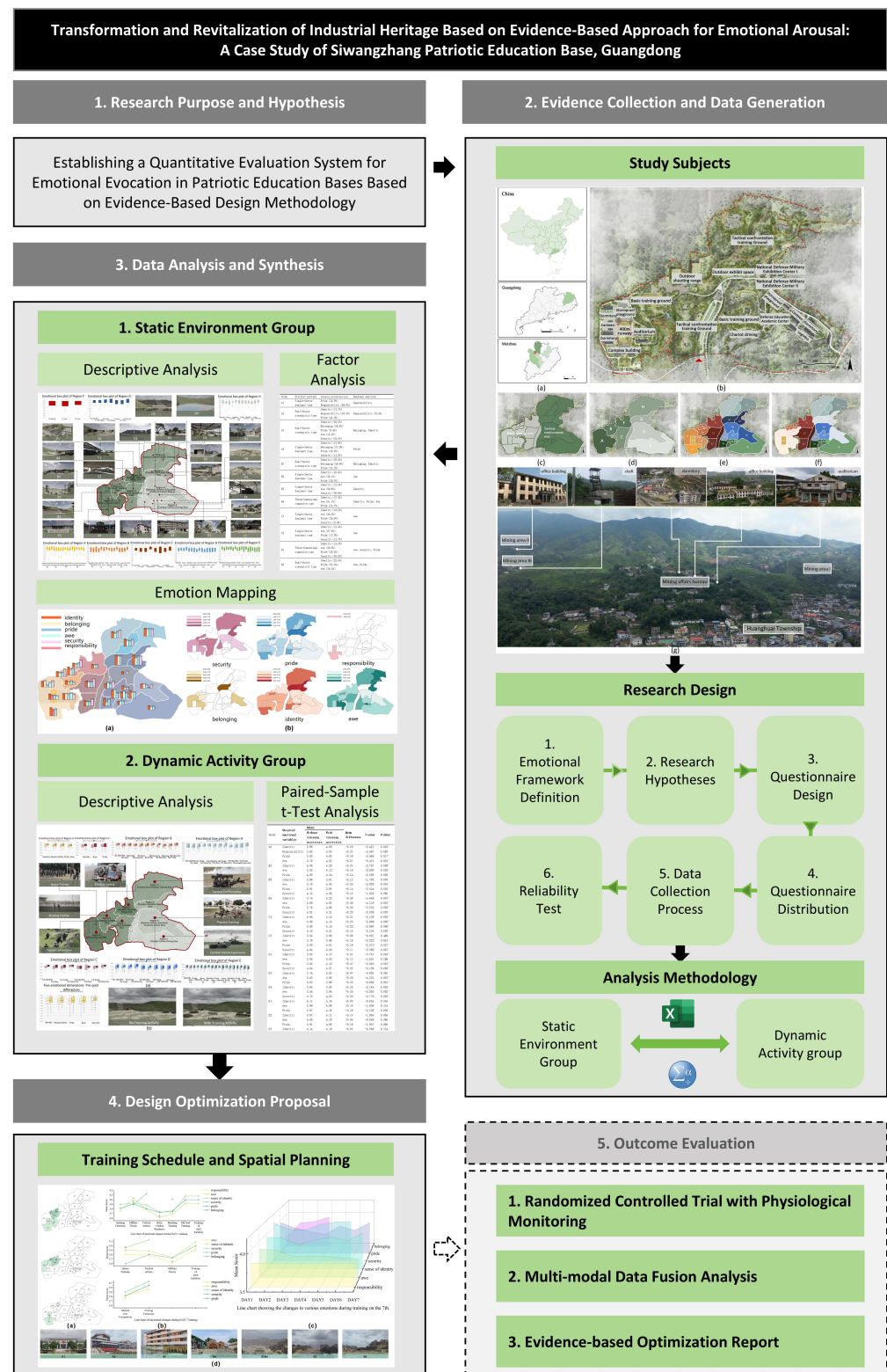


Figure 1. Research framework for spatial optimization of patriotic education base.

3.1. Study Subjects

The research site is located in the northwest of Meizhou City, at the junction of Huanghuai Town, Shizheng Town, and Meixi Town in northern Xingning City, spanning Xingning City, Pingyuan County, and Meixian District, with a total planned area of 1.046 million square meters (Figure 2a). Its predecessor was a mining area with over 400 years of coal mining history, containing reserves of 130 million tons [45]. It was once

the largest coal production base in eastern Guangdong [46]. The mining area went through development stages such as state-owned coal mines (1955) and the Mineral Bureau (1972). It was temporarily closed in 2000 due to policy-driven bankruptcy and completely exited coal production in 2005 due to a mining accident. The site retains numerous original mining support facilities, including an assembly hall, office buildings, dormitories, and shafts, most constructed in the 1950s–1960s and still standing intact after half a century (Figure 2g). In recent years, driven by national industrial transformation and urban renewal policies [3], this industrial heritage has been transformed into a patriotic education base, becoming a typical case of functional transformation of industrial relics and the continuation of regional culture. The master plan is depicted in Figure 2b.

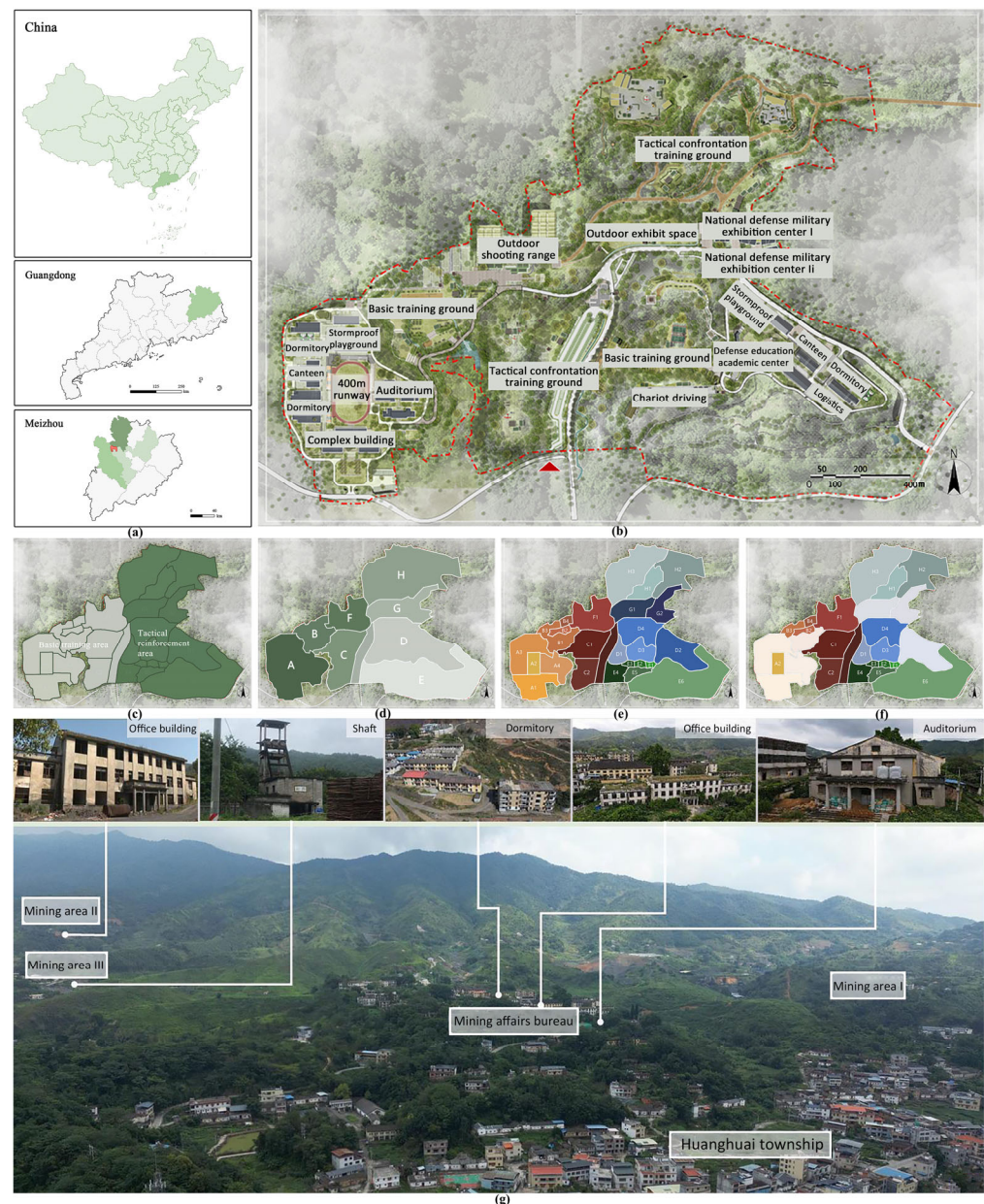


Figure 2. Spatial analysis and functional zoning of base. (a) Regional location of the study area. (b) Site master plan. (c) Primary functional zoning. (d) A–G Eight functional areas. (e) Distribution of 26 spatial nodes. (f) Nineteen nodes for training activities. (g) Annotated aerial map with heritage facilities photo-reference.

The transformation of this site into a patriotic education base is rooted in its inherent composite conditions. The complex topography and dense vegetation provide an ideal natural environment for tactical drills and covert training. The well-preserved industrial buildings from the last century, including the assembly hall and office buildings, possess robust structures and orderly, large-span layouts. These characteristics provide a solid physical foundation for converting them into training venues, barracks, and teaching facilities. Additionally, the site's historical narrative of mining struggle, embodying an ethos of dedication and national service, aligns closely with the emotional core of patriotic education, constituting a unique historical resource. In the actual renovation, these characteristics have been systematically utilized: original structures have been adaptively renovated into practical training centers and exhibition halls; existing site features such as ball courts, hills, and streams have been transformed into standard training fields, mountainous tactical zones, and water-based training areas. Furthermore, landscape interventions using local materials like rammed earth and coal gangue have allowed the physical environment to continue conveying the historical memory of the mining area. This process not only achieves a transformation of spatial functions but also shapes a patriotic education base that integrates historical authenticity with educational experiential quality.

The base is divided into two functional blocks: the Basic Training Area and the Tactical Reinforcement Area. The Basic Training Area focuses on basic tactics and individual skill training, while the Tactical Enhancement Area emphasizes large-scale confrontation drills and comprehensive capability cultivation. The first phase of the base's construction divides the 1569-acre site into eight functional regions based on site characteristics and training needs: Region A (Mineral Bureau Site), Region B (Practical Training Site), Region C (Simulated Battlefield Site), Region D (National Defense Education Academic Center Site), Region E (Combat Vehicle Driving Site), Region F (Outdoor Shooting Range Site), Region G (Outdoor Exhibition Space Site), and Region H (Tactical Confrontation Training Site).

Furthermore, based on the eight functional regions, the base is further subdivided into 26 smaller nodes (A1–H2) according to four activity types (mobilization activities, theoretical activities, practical training activities, and simulated battlefields) and site locations (Table 1). Apart from Area G, 19 typical nodes for training activities are selected from the 26 nodes. Spatial analysis and functional zoning of the base are shown in Figure 2.

Table 1. Correspondence table between activity categories and site codes.

Classification	Activity Type	Total Activity Days	Scheduled Activity Days	Activity Node
Mobilization activities	Opening ceremony	1	1	A1; A2
	Closing ceremony	1	7	A1; A2
Theoretical activities	Military theory	3	1.2.4	A3; A4; B1; D2
	Exhibition experience	2	2.5	G1
	Basic combat readiness	4	1.2.3.4	A3; A4; B1; D2
Practical training activities	Bombing training	3	1.2.3	B4; E3
	Physical training	5	1.2.3.5.6	A2; A3; B2; D3
	Shooting training	3	3	F1
	Queue training	5	2–6	A2; A3; B3; D3
	Tactical road march	1	4	no node
	Combat vehicle experience	1	3	E(1.2.4.5.6)
	Training of each battalion	6	1–6	all nodes
Simulated battlefields	Analysis of war cases	1	6	A3; A4; B1; D2
	Tactical actions	3	1.4.5	B3; D4
	Tactical confrontation	1	6	C; H
	Martial arts competition	1	7	all nodes

3.2. Research Design

The study first established a four-level classification system, dividing the research area into 2 major blocks, 8 functional regions, and 26 key nodes, among which 19 nodes contained training activities. Based on this framework, the researchers developed the following six-step experimental procedure to quantify the emotional arousal mechanisms of spatial environments and dynamic activities in the patriotic education base.

Emotional Framework Definition: This study employs a literature review and examines four types of activities within the base to systematically explore the emotional distribution characteristics across different nodes, ultimately identifying six core emotional elements: identity [16], pride [42], awe [25], belonging [43,44], responsibility, and security [37]. These constituted the unified measurement scale, forming a “6–4–3” emotional matrix where six emotional dimensions were distributed across four activity types, with each activity containing three distinct emotions (Table 2). Each node incorporated three to six emotions depending on activity types, with each emotional dimension measured by three questionnaire items.

Table 2. Mapping of emotional dimensions to activity types with corresponding assessment questions.

Emotional Dimension	Activity Types	Questions
Identity	Mobilization activities; Theoretical activities; Practical training activities; Simulated battlefields	1. After visiting the base, how would you evaluate its role in enhancing your sense of identity with China’s developmental achievements?
		2. After the visit, how do you assess the base’s effectiveness in strengthening your pride in China’s developmental progress?
		3. Following your visit, how would you rate the base’s contribution to fostering your patriotic sentiment?
Pride	Mobilization activities; Theoretical activities; Practical training activities	1. Following your visit, how would you evaluate its role in enhancing your sense of pride in China’s traditional culture and values?
		2. Following your visit, how do you assess the base’s effectiveness in strengthening your pride in China’s future development prospects?
		3. Following your visit, how would you rate its contribution to fostering your inner sense of honor?
Awe	Practical training activities; Simulated battlefields	1. Following your visit, how would you evaluate the base’s effectiveness in evoking your sense of awe toward China’s historical legacy and spiritual traditions?
		2. Following your visit, to what extent do you feel it enhanced your awe for China’s historical and cultural heritage?
		3. Following your visit, how successful was the base in cultivating your feelings of reverence for China’s historical continuity and spiritual inheritance?
Belonging	Theoretical activities	1. Following your visit, how would you rate your sense of immersion in the base’s environment?
		2. Following your visit, to what extent does the base’s environment make you want to stay longer?
		3. Following your visit, how well does the base’s environment meet your expectations?
Responsibility	Mobilization activities	1. Following your visit, how would you assess the base’s role in strengthening your sense of responsibility to preserve China’s historical and cultural heritage?
		2. Following your visit, to what extent has the base enhanced your feeling of responsibility to promote patriotic values in social practice?
		3. Following your visit, how effectively has the base inspired your determination to contribute to China’s future development?
Security	Simulated battlefields	1. Following your visit, how would you evaluate the base’s role in strengthening your confidence in the nation’s ability to safeguard citizen security?
		2. Following your visit, to what extent has the base enhanced your trust in China’s defense capabilities and overall security system?
		3. Following your visit, how effectively has the base improved your sense of personal and environmental safety?

Research Hypotheses: Based on these six defined emotions, the study hypothesized that each of the 26 spatial nodes would demonstrate a dominant emotion and that training activities in the patriotic education base would enhance emotional experiences at corresponding nodes.

Questionnaire Design: The questionnaire comprised two sections: the first collected basic information, including gender, age, and visit frequency; the second divided nodes into 26 static environment groups and 19 dynamic activity groups to conduct a comparative analysis aligned with the study's hypotheses. Each node corresponded to 3–6 emotional dimensions, with each dimension containing three 5-point Likert scale items (1 = very dissatisfied, 5 = very satisfied). Participants evaluated nodes after viewing corresponding scene model photos from at least four angles. To control order effects, static environment evaluations preceded dynamic activity assessments.

Questionnaire Distribution: During the pilot phase in January 2025, 20 first-time visitors completed online questionnaires to test question readability and stability, and all participants were college students with normal vision. The formal experiment in February 2025 recruited 40 additional students under identical conditions to complete all questionnaires independently online. And all participants completed both static and dynamic components.

Data Collection Process: Questionnaires were distributed online via the Wenjuanjun platform with IP and device restrictions. After 24 h of pilot testing, the wording of the questions was slightly adjusted based on feedback. The formal experiment collected all responses within three days, ultimately distributing 60 questionnaires with 60 valid returns.

Reliability Test: The study employed Cronbach's α coefficients to verify questionnaire reliability [47], ensuring stability and reliability of emotional measurement questions. Thirty-six independent reliability analyses were conducted for the six emotional dimensions across 26 spatial nodes. Results indicated that while some factors in Regions A, G, and H reached threshold values ($\alpha \geq 0.7$), all other emotional dimensions demonstrated α coefficients above 0.8, confirming excellent internal consistency and accurate capture of emotional arousal characteristics across different spatial environments.

3.3. Analysis Methodology

The study organized and analyzed the questionnaire data collected online. For the static environment group data, descriptive analysis was first conducted using a box plot to demonstrate the distribution characteristics of emotional scores across various nodes. Subsequently, factor analysis was performed in SPSS.26 [48], where principal component analysis was employed to extract dominant emotional factors of spatial nodes [49], thereby identifying the dominant emotions at each node. Finally, emotional mapping was created by projecting the emotional data onto the base plan, achieving spatial visualization of emotional distributions. Regarding the dynamic activity group data, the research adopted comparative analysis methods to thoroughly investigate activity modulation effects. The study first visualized the distribution changes in emotional scores before and after activities using a box plot matrix in Excel, then quantified the intervention effects through paired-sample *t*-tests in SPSS 26.

4. Results

4.1. Emotional Characteristics of Spatial Nodes

4.1.1. Descriptive Analysis

The box plot analysis of static environment groups revealed that approximately 75% of nodes across all regions fell within the 3.5–4.5 score range, with all median values exceeding 3.5 points, as detailed in Figure 3. These results demonstrated a consistently positive

emotional tendency throughout the site while indicating significant regional variations and optimization potential. In Region A, overall positive ratings were prominent, though Node A2 showed weak awe perception and high score dispersion in identity perception at Nodes A2 and A4. Region B exhibited concentrated emotional scores with relative homogeneity, yet displayed comparative weaknesses in sense of belonging at B1, awe perception at B1, and awe perception at B4.

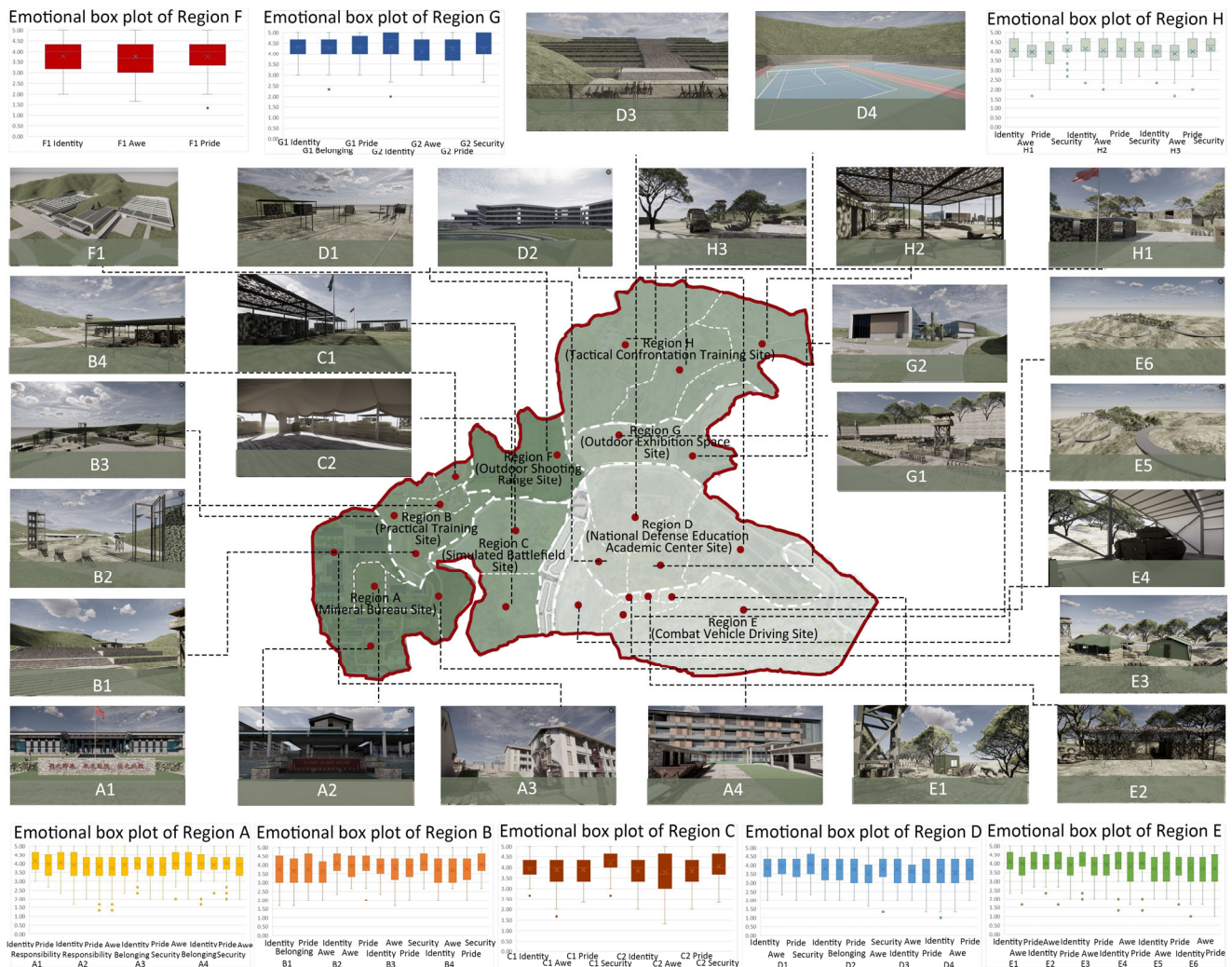


Figure 3. Box plot group of emotional dimensions across regions A–H and model diagram of each node.

While maintaining a positive emotional baseline, Region C revealed deficiencies in dimensions such as awe perception at C2. Region D demonstrated strong positive emotional foundations, but with pronounced bipolarization between high and low values. Node D1 formed a distinct peak in identity and pride perceptions, whereas Nodes D2–D4 consistently underperformed in awe perception. The technically operational nodes in Region E achieved high emotional arousal through instant feedback mechanisms, though low scores persisted in identity perception at E5, pride perception at E6, and awe perception at E6. As an independent functional unit, Region F exhibited both weak awe perception at F1 and outlier issues in pride perception at F1.

Region G and Region H generally delivered positive emotional experiences, yet presented outliers in sense of belonging at G1, identity perception at G2, security perception at H1 and H3, along with identity perception at H2. Notably, significant score fluctuations

were observed in identity perception at G2 and pride perception at H1, suggesting uneven emotional performance despite overall favorable outcomes.

4.1.2. Factor Analysis

The study employed factor analysis to reduce the dimensionality of emotional scoring data from 26 spatial nodes, with the suitability of data for factor analysis confirmed through the Kaiser–Meyer–Olkin test (KMO test) and Bartlett’s test of sphericity. Based on the squared rotated factor loading and contribution calculation method, the study quantified the variance contribution rate of each emotional dimension to latent factors, thereby identifying dominant emotional dimensions across spatial nodes. The specific procedure consisted of five key steps: (1) Determining dominant factors by applying Kaiser’s criterion (eigenvalues > 1) and scree plot inflection point analysis to select dominant factors with highest rotated variance explanation rates, ensuring effective interpretation of data variation; (2) Extracting significant loadings by screening items with absolute loading values exceeding 0.5 on dominant factors from the rotated component matrix while eliminating cross-loading interference, retaining only items significantly correlated with factors; (3) Categorizing emotional dimensions by assigning significantly loaded items to corresponding emotional dimensions according to the predefined theoretical framework, maintaining consistency with the conceptual model; (4) Calculating contribution ratios through summing squared loadings for each emotional dimension and computing their percentage of total squared sum to quantify relative importance within dominant factors; (5) Determining node types by applying contribution rate thresholds. A node is classified as single-factor dominant if the contribution rate of one emotional dimension exceeds 50 percent or significantly leads the second highest by at least 15 percentage points. It is categorized as dual-factor or three-dimensional composite if two or three dimensions each exceed 25 percent with balanced contributions within a maximum difference of 20 percentage points.

Table 3 revealed 21 nodes exhibiting clear dominant emotional structures, with significant variations in emotion across different spatial nodes. These were classified into three distinct patterns: single-factor dominant type (13 nodes), dual-factor synergistic type (6 nodes), and three-dimensional composite type (2 nodes), reflecting both the quantity and combinatorial patterns of latent emotional dimensions across nodes.

Table 3. Results of dominant affective factor analysis for each spatial node.

Node	Distinct Pattern	Variance Contribution Rate	Dominant Emotions
A1	Single-factor dominant type	Pride (32.0%) Responsibility (68.0%)	Responsibility
A2	Dual-factor synergistic type	Identity (13.7%) Responsibility (45.3%) Pride (41.0%)	Responsibility, Pride
A3	Dual-factor synergistic type	Identity (30.3%) Belonging (36.8%) Pride (9.4%) Awe (13.3%) Security (10.2%)	Belonging, Identity
A4	Single-factor dominant type	Identity (13.8%) Belonging (27.0%) Pride (35.9%) Security (13.8%)	Pride
B1	Dual-factor synergistic type	Identity (38.2%) Belonging (40.6%) Pride (21.2%)	Belonging, Identity

Table 3. Cont.

Node	Distinct Pattern	Variance Contribution Rate	Dominant Emotions
B2	Single-factor dominant type	Identity (25.6%) Awe (45.1%) Pride (29.3%)	Awe
B3	Single-factor dominant type	Identity (12.5%) Awe (36.6%) Security (50.9%)	Security
B4	Three-dimensional composite type	Identity (37.2%) Awe (31.1%) Pride (31.7%)	Identity, Pride, Awe
C1	Single-factor dominant type	Identity (19.2%) Awe (45.5%) Pride (26.9%) Security (8.4%)	Awe
C2	Single-factor dominant type	Identity (12.4%) Awe (57.4%) Pride (17.5%) Security (12.7%)	Awe
D1	Three-dimensional composite type	Identity (14.4%) Awe (30.5%) Pride (25.3%) Security (30.0%)	Awe, Security, Pride
D2	Dual-factor synergistic type	Identity (22.5%) Pride (31.3%) Awe (34.3%) Security (12.0%)	Awe, Pride
D3	Single-factor dominant type	Identity (8.1%) Awe (31.1%) Pride (60.8%)	Pride
D4	Single-factor dominant type	Awe (23.6%) Security (76.4%)	Security
E1	Single-factor dominant type	Identity (26.4%) Awe (19.8%) Pride (53.8%)	Pride
E2	Single-factor dominant type	Identity (49.8%) Awe (20.0%) Pride (30.2%)	Identity
E3	Single-factor dominant type	Identity (61.8%) Pride (38.2%)	Identity
E4	Dual-factor synergistic type	Identity (52.3%) Pride (47.7%)	Identity, Pride
E5	Single-factor dominant type	Identity (25.6%) Awe (56.5%) Pride (17.9%)	Awe
E6	Single-factor dominant type	Identity (78.5%) Pride (21.5%)	Identity
F1	Single-factor dominant type	Identity (34.7%) Pride (65.3%)	Pride
G1	Single-factor dominant type	Identity (100%)	Identity
G2	Three-dimensional composite type	Identity (28.1%) Awe (20.5%) Pride (26.8%) Security (24.6%)	Identity, Pride, Security

Table 3. Cont.

Node	Distinct Pattern	Variance Contribution Rate	Dominant Emotions
H1	Dual-factor synergistic type	Identity (43.7%) Pride (38.5%) Security (17.8%)	Identity, Pride
H2	Single-factor dominant type	Identity (29.9%) Awe (49.7%) Pride (20.4%)	Awe
H3	Single-factor dominant type	Identity (17.1%) Awe (48.0%) Pride (34.9%)	Awe

4.1.3. Emotion Mapping

Building upon the factor analysis, this study transformed the six emotional dimension scores from 26 nodes into spatial emotional intensity distribution maps through color, revealing the spatial patterns of emotional arousal in the patriotic education base. At the same time, the visualization was further enhanced by superimposing clustered column charts across different regions, which intuitively demonstrated the quantitative comparison of various emotions within each region, with column heights reflecting emotional intensity levels. This result is illustrated in Figure 4.

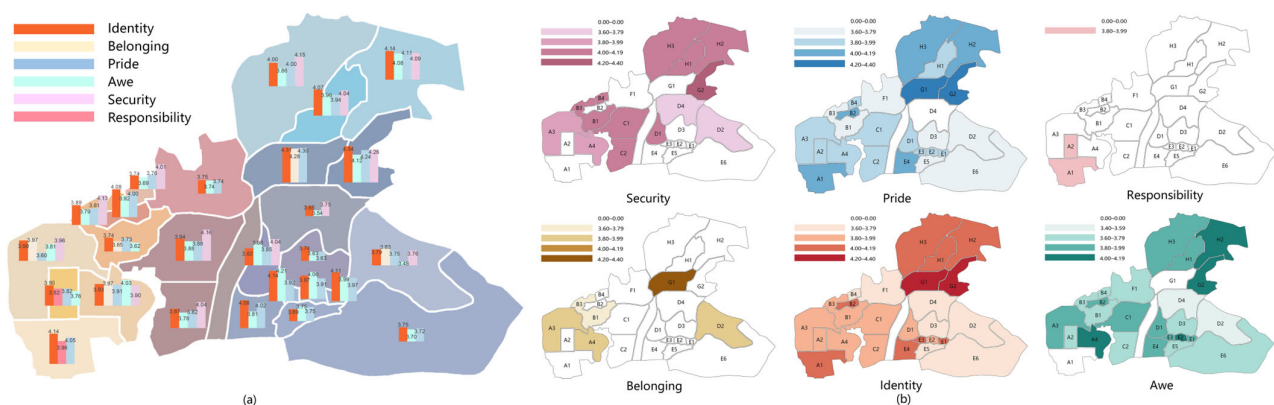


Figure 4. Spatial distribution patterns of affective scores across nodes. (a) Bar charts superimposed on base map show average scores of all emotions per node. (b) Six heatmaps depict spatial intensity gradients for each emotion.

The analysis demonstrated significant variations in emotional arousal efficacy across different functional regions. Region G emerged as the most outstanding performer, capable of comprehensively stimulating students' positive emotions, with identity and pride reaching peak values across all regions. In contrast, Region D exhibited low emotional stability, showing significantly lower scores in identity and belonging compared to other regions.

Three distinct spatial emotional distribution patterns were identified: (1) high-arousal clusters (Regions G and H) achieved synergistic emotional enhancement through multisensory stimulation; (2) single-node prominence areas (Regions A and E) excelled in arousing specific emotions at particular nodes; (3) emotional depressions (Region D), where deficiencies in activity design and spatial configuration resulted in emotional scores consistently below average. This classification not only reflected the varying effectiveness of spatial environments in emotional arousal but also provided empirical evidence for targeted optimization of patriotic education spaces.

4.2. Activity Intervention Effects

4.2.1. Descriptive Analysis

The analysis of dynamic activity group data involved zonal examination of pre-training and post-training activity data across 19 training nodes. Figure 5 demonstrated that training activities significantly enhanced emotional experiences across all nodes.

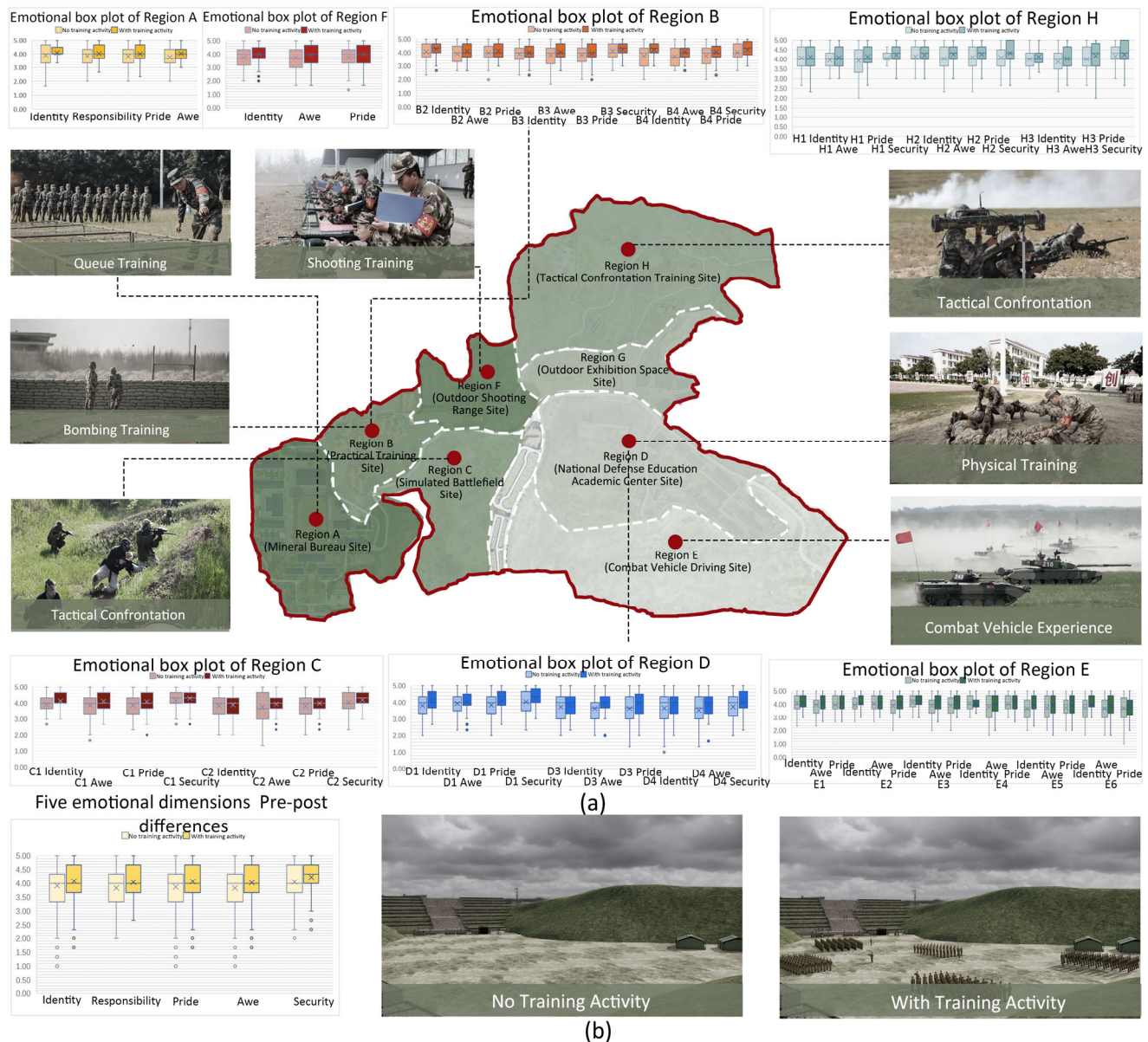


Figure 5. Box plot comparisons of affective score distributions before and after training activities. (a) Pre-training vs. post-training score distributions across regions A–H and functional scenarios for each region. (b) Five affective dimensions (excluding belonging): pre-post differences.

In Region A, mobilization activities and practical training activities elevated participants' sense of identity, responsibility, pride, and awe while substantially reducing individual variations in identity perception and awe perception. Region B's training activities improved multidimensional manifestations of patriotic sentiment and effectively unified group emotional responses, thereby strengthening team cohesion. The tactical confrontation in Region C nodes enhanced four types of patriotic emotions and promoted consistency across emotional dimensions at the aggregate level. Region D's training activities not only enhanced multidimensional expressions of patriotic sentiment but also

reduced extreme individual differences in emotional perception, consequently improving the stability of group emotions and cohesion. Through complementary tank driving and grenade-throwing exercises, Region E's practical training achieved multidimensional enhancement of patriotic emotions. Although Region F's shooting training effectively improved awe perception and partial identity perception, it requires addressing disparities in pride perception to achieve balanced development of patriotic emotions. Region H's tactical confrontation training achieved comprehensive improvement in patriotic emotions, yet requires resolving differentiation issues in security perception to ultimately accomplish balanced reinforcement and holistic enhancement across all emotional dimensions. These findings collectively demonstrate that well-designed training activities can systematically optimize emotional arousal effects in a patriotic education base while addressing existing emotional development imbalances.

Figure 5b presents the variations in five emotional dimensions across 19 typical training nodes in the comprehensive patriotic education base before and after training activities. As evidenced in the figure, the training activities exerted differential impacts on participants' emotional experiences across various dimensions.

Regarding identity perception, the data exhibited wider dispersion with numerous low scores in the absence of training activities. Following training interventions, the box plots shifted upward with increased mean values, indicating generalized enhancement of identity perception. For a sense of responsibility, pre-training evaluations demonstrated substantial variability with inconsistent responsibility levels, while post-training measurements revealed elevated mean scores. In the dimension of pride perception, baseline measurements without training activities showed broad score distributions reflecting generally low pride levels among visitors. The implementation of training activities resulted in more concentrated data distributions and higher mean values. Awe perception displayed moderate baseline scores among most visitors prior to training, with comprehensive score improvements and higher means post-training. Security perception measurements revealed relatively narrow score ranges without training activities, indicating generally high but slightly varied security levels among visitors. Training implementation yielded universally higher scores with greater data concentration, evidenced by elevated means and medians, confirming that training activities effectively enhanced visitors' security perception.

In summary, the patriotic education base's training activities, through differentiated program design, successfully enhanced participants' multidimensional emotional experiences, thereby constructing a more inclusive and profound patriotic sentiment cultivation system. This systematic emotional enhancement demonstrates the effectiveness of targeted activity design in patriotic education contexts.

4.2.2. Paired-Sample *t*-Test Analysis

The study employed paired-sample *t*-tests to evaluate emotional changes across 19 training nodes before and after activities, with all data meeting test assumptions as confirmed by Shapiro–Wilk normality tests ($p > 0.05$). The results revealed that 43 out of 66 observed emotional variables exhibited significant differences ($p < 0.05$), with 21 variables reaching high significance ($p < 0.01$), indicating a broad enhancement effect of training activities on emotional arousal, as presented in Table 4.

Table 4. Paired samples *t*-test results for affective scores across nodes before and after training.

Node	Observed Emotional Variables	Mean		Mean Difference	T-Value	<i>p</i> -Value
		Without Training Activities	with Training Activities			
A2	Identity	3.90	4.09	−0.19	−2.451	0.018 *
	Responsibility	3.82	4.03	−0.21	−2.407	0.020 *
	Pride	3.82	4.00	−0.19	−2.468	0.017 *
	Awe	3.76	4.03	−0.27	−3.431	0.001 **
B2	Identity	4.08	4.29	−0.21	−2.767	0.008 **
	Awe	3.92	4.12	−0.19	−2.500	0.016 *
	Pride	4.00	4.14	−0.14	−2.289	0.026 *
B3	Identity	3.89	4.01	−0.12	−1.793	0.079
	Awe	3.79	4.04	−0.25	−3.628	0.001 **
	Pride	3.81	3.95	−0.14	−2.454	0.018 *
	Security	4.13	4.26	−0.13	−1.920	0.060
B4	Identity	3.74	4.22	−0.48	−4.649	0.001 **
	Awe	3.69	4.05	−0.36	−4.119	0.001 **
	Pride	3.76	4.06	−0.30	−3.233	0.002 **
	Security	4.01	4.21	−0.20	−2.309	0.025 *
C1	Identity	3.94	4.15	−0.21	−3.139	0.003 **
	Awe	3.88	4.13	−0.25	−2.909	0.005 **
	Pride	3.88	4.10	−0.22	−2.890	0.006 **
	Security	4.16	4.31	−0.14	−2.124	0.038 *
C2	Identity	3.84	3.90	−0.06	−0.697	0.489
	Awe	3.78	3.96	−0.18	−2.222	0.031 *
	Pride	3.82	4.01	−0.19	−2.272	0.027 *
	Security	4.04	4.20	−0.17	−2.390	0.021 *
D1	Identity	3.82	4.13	−0.31	−3.767	0.001 **
	Awe	3.93	4.03	−0.11	−1.301	0.199
	Pride	3.85	4.12	−0.27	−3.823	0.001 **
	Security	4.04	4.27	−0.23	−3.109	0.003 **
D3	Identity	3.74	3.81	−0.07	−0.865	0.391
	Awe	3.63	3.93	−0.30	−4.331	0.001 **
	Pride	3.63	3.96	−0.33	−3.689	0.001 **
D4	Identity	3.65	3.85	−0.20	−2.184	0.034 *
	Awe	3.54	3.84	−0.30	−3.292	0.002 **
	Security	3.75	4.05	−0.30	−3.776	0.001 **
E1	Identity	4.11	4.16	−0.05	−0.654	0.516
	Awe	3.99	4.09	−0.10	−1.608	0.114
	Pride	3.97	4.16	−0.18	−2.158	0.036 *
E2	Identity	3.97	4.11	−0.13	−1.894	0.064
	Awe	4.06	4.10	−0.04	−0.549	0.586
	Pride	3.91	4.06	−0.16	−1.927	0.060
E3	Identity	4.14	4.18	−0.03	−0.369	0.714
	Awe	3.95	4.08	−0.13	−1.957	0.056
	Pride	3.92	4.15	−0.23	−3.176	0.003 **
E4	Identity	4.08	4.05	0.03	0.455	0.651
	Awe	3.81	4.01	−0.20	−1.919	0.060
	Pride	4.02	4.16	−0.14	−1.712	0.093
E5	Identity	3.69	3.97	−0.28	−3.537	0.001 **
	Awe	3.75	3.94	−0.18	−1.813	0.076
	Pride	3.75	3.93	−0.18	−2.146	0.037 *
E6	Identity	3.75	3.98	−0.23	−2.416	0.019 *
	Awe	3.70	3.89	−0.19	−2.406	0.020 *
	Pride	3.72	3.81	−0.09	−0.956	0.343

Table 4. Cont.

Node	Observed Emotional Variables	Mean		Mean Difference	T-Value	p-Value
		Without Training Activities	with Training Activities			
F1	Identity	3.75	4.01	−0.26	−3.033	0.004 **
	Awe	3.74	3.92	−0.18	−2.222	0.031 *
	Pride	3.74	3.97	−0.23	−2.610	0.012 *
H1	Identity	4.07	4.12	−0.05	−0.688	0.495
	Awe	3.96	4.08	−0.12	−1.689	0.097
	Pride	3.94	4.14	−0.20	−2.173	0.034 *
	Security	4.04	4.23	−0.18	−2.589	0.012 *
H2	Identity	4.14	4.21	−0.08	−1.302	0.198
	Awe	4.04	4.26	−0.21	−2.785	0.007 **
	Pride	4.11	4.27	−0.16	−2.538	0.014 *
	Security	4.09	4.33	−0.24	−3.454	0.001 **
H3	Identity	4.00	4.14	−0.14	−1.890	0.064
	Awe	3.86	4.04	−0.18	−2.352	0.022 *
	Pride	4.00	4.19	−0.19	−1.964	0.055
	Security	4.15	4.25	−0.10	−1.477	0.146

* $p < 0.05$ ** $p < 0.01$.

Regional comparisons indicated differentiated impacts: Region A exhibited significant differences in all nodal emotional scores; Region B showed p -values below 0.05 for all nodes and corresponding emotions except B3 identity perception and B3 security perception; Region C demonstrated significant positive impacts on observed emotions except C2 identity perception; Region D displayed significant score differences for all nodal emotions except D1 awe perception and D3 identity perception. Region E presented 18 observation variables with 12 showing p -values exceeding 0.05, indicating misalignment between observed emotions and training activities. Region F manifested significant differences in all post-activity emotional observations, while Region H showed p -values > 0.05 for identity perception across all nodes, plus H1 awe perception, H3 pride perception, and H3 security perception, suggesting insignificant training impacts on these dimensions, with the remaining variables exhibiting $p < 0.05$ significance.

Further analysis revealed selective associations between activity types and emotional dimensions. Queue training showed insignificant effects on identity and security perceptions; tactical confrontation, due to excessive competitiveness, shifted participant focus toward goal achievement rather than emotional experience, hindered deep identity perception development; physical training failed to evoke awe perception without higher-level meaning guidance; bombing training significantly enhanced pride perception while leaving identity and awe perceptions unchanged. Notably, combat vehicle experience in region E showed insignificant changes in identity, awe, and pride perceptions at certain nodes, indicating dimensional misalignment with activities. The technically oriented driving tasks, when lacking integration of collective honor or mission objectives, proved ineffective in stimulating identity perception, pride perception, or responsibility-related awe.

5. Discussion

Through systematic quantitative analysis, this study elucidated fundamental patterns of spatial–emotional arousal within patriotic education bases, with key findings summarized across two dimensions. First, in terms of static environmental emotional characteristics, factor analysis identified 21 nodes exhibiting distinct dominant emotions. Subsequent emotion mapping delineated three spatial distribution patterns: high-arousal clusters (regions G and H), single-node prominence areas (regions A and E), and emotional

depressions (region D). These results empirically substantiate the existence of “space–emotion” mapping relationships and provide a scientific basis for spatial optimization strategies—namely, by enhancing group interaction in high-performance regions such as G to capitalize on existing emotional resources, and by incorporating situational simulation devices in low-arousal areas such as D to remediate emotional deficiencies.

Second, in assessing the modulation effects of dynamic activities, paired-sample *t*-tests revealed significant improvement in 66.7% of the observed emotional variables. These quantitative findings establish causal “activity–emotion” relationships, thereby addressing a key empirical gap in extant research concerning the impact of dynamic activities on emotional arousal mechanisms. Moreover, the analysis identified activity-specific associations: collaborative activities proved effective in eliciting multidimensional emotional responses, whereas technical activities that lacked elements of collective meaning exhibited limited arousal potential. Three distinct patterns of modulation failure were observed in cases of inadequate emotional arousal: (1) mechanically repetitive activities failed to generate a sense of identity due to insufficient emotional engagement; (2) technical operations did not align with multidimensional affective demands; and (3) individual cognitive differences led to divergent awe responses. These results offer specific guidance for optimizing training design, namely, by embedding collaborative components within technical operations and enhancing activities with higher-order purposeful experiences through situational narrative construction.

The spatial and activity dimensions identified in this study provide a robust scientific foundation for pathway optimization. The findings underscore the vital synergistic effect of “space–behavior” interactions: significant emotional enhancement is achieved when activity design aligns with the emotional characteristics of specific spatial nodes, whereas misalignment may result in emotional suppression. These insights inform three-dimensional optimization strategies: spatially, by leveraging the anchoring effects of high-arousal nodes; in terms of activity, by precisely aligning empirically validated effective activity types with the emotional profiles of each zone; and temporally, by adopting phased reinforcement in accordance with psychological principles governing emotional accumulation. This theoretical framework supports the design of a seven-day progressive training program, ensuring that optimization strategies honor the inherent spatial–emotional characteristics while maximizing the efficacy of activity-induced emotional arousal.

5.1. Training Schedule and Spatial Planning

Building upon the aforementioned findings, this study develops a seven-day progressive training program tailored to the emotional cultivation needs of alienated students in patriotic education. Concurrently (Figure 6), it optimizes existing activity schedules through evidence-based spatial planning.

The initial training day adopts a “ritual-theory” model focusing on establishing fundamental emotional connections. The designed pathway A2–A4–B3–B1–B4–B2 incorporates: morning opening ceremony and queue training at Node A2 (6:30–9:00), transforming indifference into preliminary identity, pride and awe; military theory sessions at Node A4 (9:00–11:00) elevating awe perception to daily peaks while establishing baseline security perception and sense of belonging; tactical actions at Node B3 (11:00–12:00) maintaining emotional stability; basic combat readiness at Node B1 (14:30–15:00) and bombing training at Node B4 (15:00–17:00) with slight emotional dips; concluding with physical training and training of each battalion at Node B2, where students first experienced the emotional weight of “shared goals,” pushing identity and pride perceptions to daily maxima.

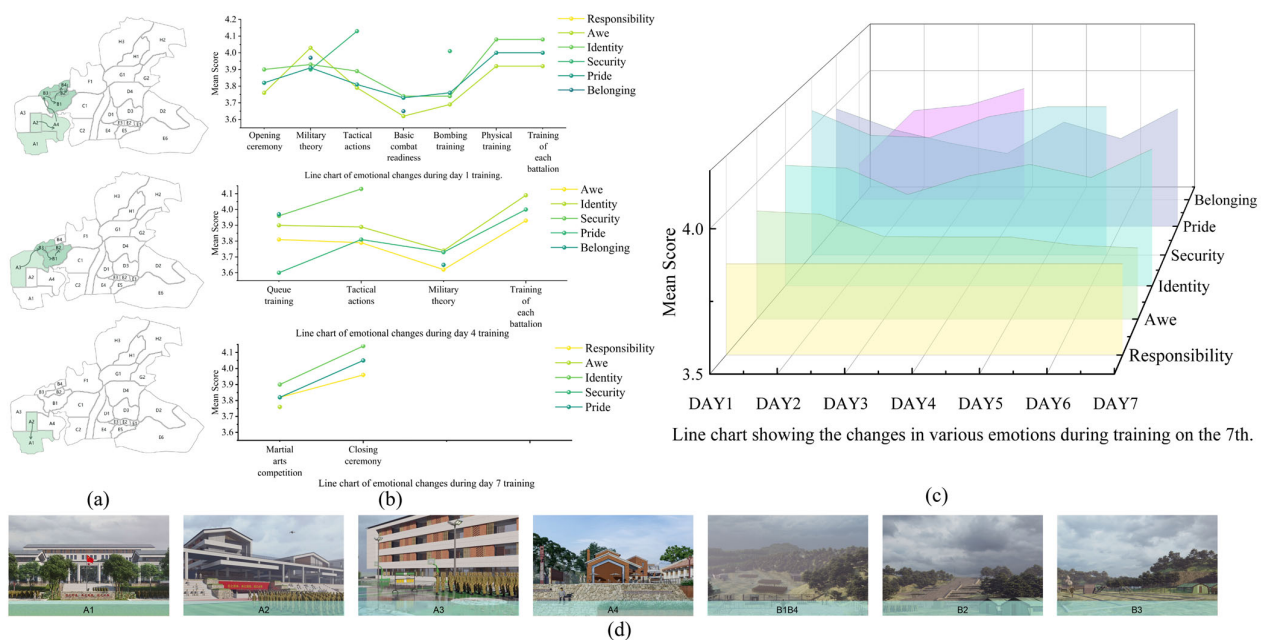


Figure 6. Temporal-spatial dynamics of training activities and affective responses: (a) Day 1, 4, and 7 movement trajectories superimposed on base map. (b) Line chart of emotional changes during DAY 7 training. (c) Line chart showing the changes in various emotions during training on the 7th. (d) Spatial models of active nodes.

The representative fourth day demonstrates key mechanisms for emotional deepening through pathway A3-B3-B1-B2: queue training at Node A3 (6:30–7:00) effectively instilling discipline-related awe alongside emerging national belonging, identity, security and pride; tactical actions at Node B3 (8:00–10:00) enhancing pride through skill mastery while collective order bolstered security perception; military theory sessions at Node B1 (10:00–12:00) significantly deepened emotional internalization; training of each battalion at Node B2, where identity, pride and awe perceptions reached their daily zenith through accumulated experiences.

The seventh-day integration effects proved particularly remarkable via pathway A2-A1: martial arts competition at Node A2 (8:00–12:00) featuring diversified drills intensely stimulated responsibility and pride alongside collective identity and awe; the closing ceremony at Node A1 (14:30–18:00) catalyzed peak manifestations of identity, protective responsibility and patriotic pride.

As illustrated in Figure 4, this progressive pathway design achieved qualitative transformation through quantitative emotional accumulation. The complete emotional cultivation loop comprised rapid activation (initial days), stability development (middle phase) and internalization (final phase). Meanwhile, responsibility, security and pride perceptions maintained robust stability through weekly fluctuations, belonging and identity perceptions demonstrated steady upward trajectories. The program successfully transformed students from passive resistance to active engagement, cultivating comprehensive patriotic sentiment that nurtured responsible and compassionate youth with profound reverence, pride and trust in their nation.

It must be noted that as the base remains in the planning phase, this study completes the first four stages of evidence-based design, leaving post-occupancy evaluation (POE) for subsequent research. Upon the base's completion, the proposed solution will be validated through the following approaches: (1) A randomized controlled trial with physiological monitoring; (2) Multi-modal data fusion analysis; (3) Evidence-based optimization report.

5.2. Limitations and Future Considerations

While this study yields important findings, several limitations merit acknowledgment, particularly with respect to sample representativeness, measurement methodologies, and program validation. First, due to research constraints, participants were predominantly sourced from the 18–30-year-old student demographic. Given that patriotic education is a lifelong process, future research should broaden participant sampling to encompass both younger children and older adults, thus enabling a systematic examination of how cognitive developmental stages modulate emotional arousal effects. Methodologically, the current reliance on Likert-scale self-report data could be enhanced by integrating multimodal measurement technologies, including physiological monitoring, behavioral trajectory analysis, and other objective metrics, to construct a more comprehensive and precise emotional assessment system. Regarding program validation, it is necessary to adopt a phased implementation strategy: initial short-term pilot studies in underperforming regions should facilitate direct comparisons between optimized and traditional approaches; subsequently, long-term integration with digital twin technology can support the creation of hybrid physical-digital evaluation platforms, thereby enabling dynamic and iterative design refinement. This multi-stage validation process will both substantiate the theoretical model proposed herein and yield robust empirical data for applications in patriotic education contexts.

The application of this study to industrial heritage transformation projects also highlights avenues for improvement. Taking the Siwangzhang base—the redevelopment site of eastern Guangdong’s largest coal mine—as an example, although original industrial structures have been preserved, evocative elements such as mine shafts and coal preparation plants remain underutilized. Furthermore, this study has a certain perspective limitation: the questionnaire design focused on measuring universal patriotic emotions, without specifically including questions to assess emotional perceptions of the industrial heritage. This may have partially obscured the potential role of the unique site identity of the “historical coal mine site” in emotional arousal. This observation suggests that future patriotic education bases should place greater emphasis on both the preservation and activation of industrial heritage components to more effectively leverage their educational and emotional potential.

Three principal research directions warrant further scholarly attention. First, at the theoretical level, it is essential to deepen investigations into the underlying mechanisms of “space–behavior–emotion” interactions across a range of patriotic education base typologies. Second, from a technological perspective, future efforts should focus on the development of intelligent assessment systems that amalgamate multimodal data sources to enable real-time monitoring and dynamic prediction of emotional arousal. Third, at the practical level, priority should be given to the formulation and implementation of comprehensive Emotional Design Standards tailored for patriotic education bases, with particular consideration given to dedicated sections addressing industrial heritage contexts. In this standard, guidelines for emotional transformation techniques and spatial intervention strategies specifically targeting industrial heritage elements could be further incorporated to enhance the engineering applicability and architectural orientation of the standards.

With regard to industrial heritage transformation, future research should focus on several pivotal areas. First, constructing a theoretical framework that systematically maps the spatial characteristics of industrial sites to distinct emotional dimensions of arousal is crucial. Second, it is particularly essential to delve into the narrative potential and emotional symbolism of typical components such as mine shafts and coal preparation plants, and to incorporate a measurement dimension for “historical site perception” in quantitative evaluations. Concurrently, actionable spatial intervention design guidelines should be

developed, clarifying strategies—from an architectural and engineering perspective—for enhancing spatial narratives, embedding emotional touchpoints, and implementing functional composite design to improve the efficacy of emotional transmission. Furthermore, the application of digital technologies in heritage interpretation and experience enhancement should be explored, and efforts should be made to promote the establishment of a closed-loop workflow covering assessment, conservation, and activation. Finally, future research should also extend to non-military scenarios of heritage revitalization, examining the similarities and differences in the emotional arousal mechanisms of industrial heritage under different functional uses, in order to enhance the generalizability and cross-typological applicability of the findings. These advancements would contribute to both theoretical enrichment and practical innovation, empowering industrial heritage to assume a more substantive role within contemporary patriotic education initiatives.

6. Conclusions

This study establishes an evidence-based framework that shifts the design of patriotic education bases from a functional to an emotion-oriented paradigm, using the Siwangzhang industrial heritage case. This study reveals two core principles of emotional arousal in patriotic education bases. At the static level, the spatial distribution of emotions follows a structured pattern, manifested as distinct regional tendencies to dominantly arouse specific emotions, which form identifiable spatial modes such as high-arousal clusters, single-node prominence areas, and emotional depressions. At the dynamic level, the effectiveness of activities adheres to a clear matching principle; while training activities generally enhance emotional experience, their efficacy significantly depends on the alignment between the activity type and the emotional characteristics of the space. Collectively, these results underscore the synergistic “space–behavior” effect; activities that align with the emotional characteristics of spatial nodes markedly enhance outcomes, whereas misalignment may result in emotional suppression. These insights provide a robust theoretical foundation for pathway optimization, ensuring that subsequent design interventions both respect spatial emotional attributes and maximize arousal efficacy.

The core findings of this study are applicable to optimizing various types of patriotic education bases, despite being based on the Siwangzhang industrial heritage case. The limitations of this study primarily concern the narrow age range of participants and the reliance on subjective evaluation methods. Future research should expand sample diversity, integrate multimodal assessment technologies, and promote the formulation and adoption of Emotional Design Standards for patriotic education bases to advance a paradigm shift towards evidence-based practice. Through this systematic research, the study provides a scientific pathway for enhancing patriotic education bases and explores new approaches for transforming industrial heritage to renew its social value.

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