Al-Ishlah: Jurnal Pendidikan
Vol.18, 1 (March, 2026), pp. 1430-1443
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v18i1.9015

Restorative Characteristics of School Gardens and Student Well-Being: Evidence from Indonesian High Schools

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ARTICLE INFO

Keywords:

restorative school gardens;
attention restoration theory;
psychological well-being;
learning motivation;
high school students

Article history:

Received 2025-11-26
Revised 2026-02-13
Accepted 2026-03-31

ABSTRACT

School-based green spaces are increasingly recognized as supportive environments for adolescent well-being, yet empirical evidence from Indonesian secondary schools remains limited. Drawing on Attention Restoration Theory (ART), this study examines how school gardens contribute to students' psychological recovery and learning-related outcomes. This study employed a convergent mixed-methods design involving 566 high school students (aged 15–18) from SMA and MA schools in Jambi Province, Indonesia. Quantitative data were collected an online questionnaire measuring perceived restorativeness (Being Away, Fascination, Extent, Compatibility), visit patterns, and reported effects. Qualitative data were obtained from open-ended responses, interviews, and field observations of garden features. Data were analyzed using descriptive statistics, correspondence analysis with chi-square tests (α = 0.05), and thematic content analysis. Students frequently used school gardens, primarily during break times for relaxation. Perceived restorativeness was strongly associated with gardens characterized by dense vegetation, canopy shade, water elements, and supportive facilities such as seating and gazebos. Students reported reduced stress, improved mood, and clearer thinking following garden visits. Correspondence analysis confirmed significant associations between restorative characteristics and environmental features, while qualitative findings reinforced the importance of vegetation and social spaces in shaping restorative experiences. The findings support ART by demonstrating that school gardens function as everyday restorative environments that enhance emotional regulation and attentional readiness. Integrating natural and functional design elements can strengthen the role of school gardens as learning-support infrastructure.

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1. INTRODUCTION

Evidence from high income settings consistently shows that contact with parks and everyday green spaces is associated with lower stress, mental refreshment, and a stronger sense of calm and tranquility (Khaleghimoghaddam, 2024; Zhang et al., 2024). In environmental psychology, natural features such as trees and grass are also linked to greater perceived safety and reduced tension in urban environments (Khomaeny et al., 2020). These findings support a broad conclusion that natural environments can function as restorative settings that help people recover from mental fatigue and emotional strain.

This issue is especially relevant for adolescents. UNICEF in The State of the World's Children 2021 On My Mind reports that one in seven adolescents aged 10 to 19 experiences mental health problems, including anxiety and persistent fatigue. In senior secondary education SMA and MA, academic demands such as preparation for high stakes examinations and uncertainty about post school pathways often intensify stress and emotional pressure (Legiran, 2015; Mutiah, 2019; Triwilandari, 2014; Yuliani, 2018). Stress responses activate the nervous system and, when prolonged, may contribute to physical complaints and psychological difficulties (Marliani, 2015; Wijono, 2010). In educational terms, stress and mental fatigue matter because they can undermine attention, persistence, and willingness to engage in learning tasks. Therefore, school environments that support emotional regulation and attentional recovery are not only a public health concern but also a core education concern.

However, school development is often dominated by classrooms and hard infrastructure, while low complexity green open spaces are treated as secondary. As a result, school grounds may lack usable green areas that students can access for brief recovery during the school day. Yet even modest green spaces can operate as buffers against boredom, fatigue, and academic stress. Policy direction globally has encouraged the use of natural environments to support health and well being (DEFRA, 2011). In Indonesia, Law No. 18 of 2014 on Mental Health emphasizes promotive and preventive approaches that can be connected to school planning and student support. From an education perspective, school gardens are not simply decorative areas. They are part of the learning infrastructure that shapes daily experiences, school climate, and students' readiness to learn.

To explain how natural settings support recovery, Attention Restoration Theory ART provides a clear and testable framework. ART proposes that environments facilitate recovery from directed attention fatigue through four restorative characteristics. Being Away refers to a sense of mental distance from routine demands. Fascination reflects effortless attention drawn by interesting natural features. Extent refers to a coherent setting that feels rich enough to explore. Compatibility describes the fit between the setting and a person's goals and intended activities. Perceived restorativeness is commonly measured using the Perceived Restorativeness Scale PRS. In school contexts, design features such as dense shade trees, water elements, and supportive facilities such as gazebos, seating, and walking paths are expected to strengthen restorative experiences. In turn, restoration can support calm affect, clearer thinking, and renewed motivation to participate in learning. This pathway positions school gardens as relevant not only to environmental psychology but also to education research focused on student wellbeing, engagement, and learning motivation.

Despite strong international evidence and the clarity of ART and PRS, the Indonesian school context remains understudied, particularly at the SMA and MA levels. Three gaps are especially important. First, Indonesian evidence on students' perceived restorativeness in school gardens is limited, making it difficult to translate global findings into locally grounded guidance. Second, school-based applications of ART that focus on everyday garden use during the school day remain scarce, even though school is where adolescents spend most of their time. Third, existing work seldom links specific physical garden elements to both restorative perceptions and learning motivation, leaving uncertainty about which design features are most impactful and feasible for schools. Addressing these gaps is essential for education research because it clarifies which environmental conditions support students' emotional recovery and learning readiness in real school settings.

Accordingly, this study investigates school gardens in Jambi Province, with a focus on SMA and MA settings in Jambi City, to examine how restorative characteristics are experienced by students and which

physical elements appear most supportive. The study is guided by the following objectives. First, to describe how students perceive the four restorative characteristics of school gardens, namely being away fascination extent and compatibility. Second, to identify and categorize students' post visit psychological responses, including affective responses such as calmness, cognitive responses such as clearer thinking, and social responses such as willingness to interact positively. Third, to examine which physical garden elements, including vegetation shade, water features, and supporting facilities, are most strongly associated with perceived restrictiveness and learning motivation in the observed school settings.

Based on ART, the study also expects that higher perceived restrictiveness will be associated with more positive psychological responses and stronger learning motivation, and that gardens with denser vegetation shade, water elements, and comfortable seating or shelter will be reported as more restorative than gardens with limited natural features.

2. METHODS

2.1 Design

This study used a convergent mixed methods design. Quantitative and qualitative data were collected in the same phase and integrated during interpretation. The survey measured perceived restrictiveness and visit patterns, while open-ended responses, interviews, and field observations provided contextual explanations of student experiences and the physical elements present in school gardens.

2.2 Setting and participants

The study was conducted in senior high schools and Islamic senior high schools across Jambi Province, Indonesia. The survey dataset comprised 566 students aged 15 to 18 drawn from multiple cities and regencies in the province. Responses were screened for completeness and analyzed as a single dataset of valid cases. Convenience sampling was used through school networks and student communication channels to reach participants from multiple schools. This approach enabled broad access but may introduce selection bias, findings are interpreted as context-specific patterns rather than population estimates.

2.3 Variables and operational definitions

The study focused on personal characteristics, visit characteristics, and perceived restrictiveness based on Attention Restoration Theory and PRS-aligned measures.

Table 1. Study variables and indicators

No.	Variable	Indicators examples	Key references
1	Personal characteristics	Age; gender; grade level	Korpela et al. 2002; Scopelliti and Giuliani 2004; Korpela and Ylén 2007; White et al. 2013
2	Visit characteristics	Time of visit; duration; frequency; group size; motivation	Scopelliti and Giuliani 2004; Korpela et al. 2002; Korpela et al. 2008; White et al. 2013
3	Perceived restrictiveness	Being Away; Fascination; Extent; Compatibility	Kaplan and Kaplan 1989; Hartig et al. 1991

2.4 Instruments and measures

Two instruments were used: First, an online questionnaire was administered using Google Forms. It included demographics, visit profile, PRS-aligned items for the four restorative characteristics, photo-based selections, and open-ended prompts on felt effects after time in the garden. Second, an observation checklist was used during site visits to document vegetation structure, water features, supporting facilities such as gazebos and benches, circulation paths, landscape furniture, and hardscape conditions.

Reliability and validity were addressed in two ways. Instrument development followed established ART and PRS constructs and was pilot tested prior to full deployment. Internal consistency of the PRS-aligned items was assessed using Cronbach's alpha for each ART dimension and the overall scale, and the coefficients are reported in the Results section.

2.5 Photo stimuli

The questionnaire included a small set of standardized photo stimuli that represented typical school garden scenes and common facilities such as shaded seating, garden paths, gazebos, and activity areas. The photos were embedded in the same format within the online questionnaire so that all respondents viewed identical stimuli. The stimuli were reviewed during pilot testing to ensure clarity and consistent interpretation.

2.6 Procedures and data collection

Data collection combined an online survey, in-depth interviews, and field observations. The survey link was distributed through school communication channels and student group messaging. Field observations were conducted across representative school garden sites, and interviews were conducted with selected students to deepen the interpretation of survey responses. Access to school sites was coordinated with participating schools.

2.7 Data analysis and integration

Quantitative analysis used descriptive statistics to summarize respondent profiles, visit patterns, and PRS-aligned perceptions. Correspondence analysis with chi-square-based tests was used to explore associations among categorical variables such as photo selections, ART dimensions, visit patterns, and coded response categories. Qualitative analysis used content analysis with open coding, axial coding, and selective coding to organize open-ended responses into affective, cognitive, and social response categories. Integration occurred at interpretation by comparing patterns from correspondence analysis with themes from qualitative coding and observed physical features.

Table 2. Data collection and analysis matrix

Objective	Required input data	Data collection method	Analysis technique
Describe restorative characteristics linked to student responses	PRS aligned perceptions and reported effects	Questionnaire with closed items, open ended items, and photo stimuli	Descriptive statistics and content analysis
Classify response categories	Open ended descriptions of experiences	Questionnaire open ended responses and interviews	Open, axial, and selective coding
Examine associations among perceptions, visits, and responses	Cross tabulated categorical variables	Questionnaire and coded categories	Correspondence analysis with chi square tests
Identify influential physical elements	Features present in school gardens	Observation checklist and student descriptions	Triangulation across observation and coded themes

Analyses were conducted using JMP version 13 with alpha set at 0.05 for inferential tests within correspondence analysis.

2.8 Ethical considerations

The study followed institutional guidance for research involving minors. Students provided informed assent, participation was voluntary and anonymous, and no identifying information was collected or reported. Parental or guardian consent was facilitated through schools when required.

School access and data collection procedures were coordinated with participating institutions to ensure appropriate safeguarding.

3. FINDINGS AND DISCUSSION

3.1 Visit Patterns in the School Park (Quantitative Results)

Visit-pattern data were collected to contextualize students' exposure to the park and to interpret subsequent restorative outcomes. The questionnaire captured visit frequency, visit duration, companionship, timing of visits, and primary motivations (N = 566). Visit frequency. Most students reported frequent park use. 67.79% (n = 383) visited the park more than three times per month, followed by 17.52% (n = 99) who visited twice a month and 12.21% (n = 69) who visited once a month. Only 2.48% (n = 14) reported never visiting the park. This distribution indicates that the park is a regularly used school facility, suggesting its practical relevance for student well-being. Visit duration. Park visits were generally short and compatible with school schedules. The most common duration was around 1 hour (39.17%, n = 222), followed by around 2 hours (22.08%, n = 125) and less than 30 minutes (21.25%, n = 120). The remaining students reported longer durations, indicating that while most visits occur in brief intervals, a subset of students spend extended time in the park.

Companionship. Park use was predominantly social. Most students visited with friends (74.51%, n = 421), while 10.8% (n = 61) visited alone. An additional 11.68% (n = 66) used the informal label "temen" (peers), indicating relaxed peer-based visits. Only 0.7% (n = 4) visited with a teacher, suggesting that visits are rarely embedded in supervised instructional activities.

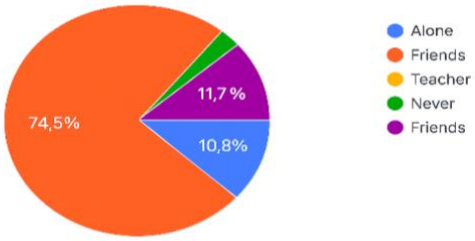

Figure 1. Companions during students' school park visits (N = 566).

Timing of visits. Visits occurred most commonly during break time (60.88%, n = 344), indicating that breaks function as the main window for outdoor recovery. Other visit times included morning before classes (15.93%, n = 90), specific class periods (15.22%, n = 86) (e.g., PE or related lessons), and after school (5.49%, n = 31). A small proportion reported never visiting (2.48%, n = 14).

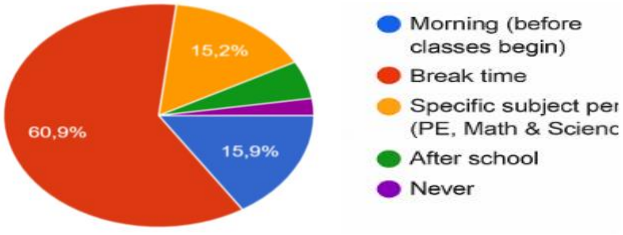

Figure 2. Timing of students' school park visits (N = 566).

Motivations. Students' motivations were predominantly restorative. Relaxation was the most frequently reported reason (69.2%, n = 391), highlighting the park's function as a place to reduce stress and regain calm. Other motivations included exercise (10.09%, n = 57), eating (7.26%, n = 41), and studying (7.26%, n = 41). A smaller group reported no specific motivation or non-use (6.19%, n = 35). Overall, the visit-pattern evidence positions the school park as both a social space and a restorative space, with relaxation as the dominant motive.

3.2 The Park as a Restorative Environment (ART Framework and Photo-Stimulus Assessment)

To interpret restorative experiences more theoretically, this study applied Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989), which proposes four characteristics supporting recovery from mental fatigue: Being Away, Fascination, Extent, and Compatibility. Students evaluated restorative qualities using photo stimuli and ART-guided prompts derived from the Perceived Restorativeness Scale (Hartig et al., 1991).

Examples of the guiding prompts were:

1. Being Away: What type of park environment helps restore you from boredom, routine, and daily school activities?
2. Fascination: What kind of park environment attracts you, consciously or unconsciously?
3. Extent: Which area of the park is easy to recognize and explore?
4. Compatibility: Which park environment aligns with your interests or goals?

Figure 3. Naturalistic woodland garden setting used as a visual stimulus for ART-based restorative perception (Being Away/Fascination).

Figure 4. Structured ornamental garden landscape used as a visual stimulus for ART-based restorative perception (Extent/Compatibility).

The visual stimuli helped standardize students' interpretations of ART constructs by providing concrete environmental representations. Students selected the images that best matched each ART prompt, and associations between selected photos and ART dimensions were examined using the study's planned analyses (e.g., correspondence/correlation outputs).

3.3 Being Away (Quantitative Results + Interpretation)

Being Away refers to an environment that provides psychological distance from routine demands. The analysis indicated a significant association between selected photos and the Being Away dimension, with the strongest alignment observed for a photo characterized by dense canopy trees and a pavilion, suggesting that enclosed natural settings were perceived as the clearest "escape" from everyday school routines.

Figure 5. Park photo most frequently chosen by students for the Being Away dimension.

Interpretively, students' selections suggest that restorative detachment is supported by high greenness, enclosure, and distinctive natural–architectural features (e.g., pavilion/pergola), which are less available in typical classroom contexts. This aligns with research indicating that greener outdoor environments and the sense of spatial enclosure can facilitate psychological distance and recovery from directed attention demands (Kaplan, 1995; Nordh, 2009; Dee, 2003; Hartig et al., 2015).

3.4 Fascination (Quantitative Results + Interpretation)

Fascination refers to an environment's capacity to hold attention effortlessly. The correspondence analysis showed significant associations for both sites. Garden A (with a waterscape) and Garden B (with a flower-garden landscape) were each strongly linked to Fascination.

Figure 6. Visual stimuli for the Fascination dimension (ART): Garden A (waterscape setting) and Garden B (flower-garden setting).

The findings are consistent with evidence that water and rich vegetation can function as inherently captivating features, supporting soft fascination and calm (Kaplan et al., 1998; Purcell et al., 2001; Laumann et al., 2003; Nordh, 2009; White, 2010). In Garden B, floral composition and structured planting may similarly attract attention and encourage visual exploration, supporting restorative experience through engaging yet non-demanding sensory input (Ulrich, 2007).

3.5 Extent (Quantitative Results + Interpretation)

Extent refers to the perceived coherence and scope of an environment that supports exploration. The analysis demonstrated a significant relationship between selected photos and Extent. Students associated Extent with scenes featuring recognizable paths, seating zones, and supportive park features, indicating that legible layout and navigable spaces contribute to perceived "room to explore."

Figure 7. Visual stimuli for the Extent dimension (ART): Garden A (seating area and park facilities) and Garden B (pathway/landscape furnishings supporting exploration).

These results align with ART's emphasis that extent depends on the connectedness and coherence of perceived elements, enabling users to organize the scene and imagine continued exploration (Kaplan & Kaplan, 1982; Kaplan et al., 1989).

3.6 Compatibility (Quantitative Results + Interpretation)

Compatibility reflects the match between environmental affordances and intended activities. Students associated Compatibility in Garden A with scenes including a gazebo and jogging track, while

Compatibility in Garden B aligned with a playground area, indicating that students perceive restorative value when the space supports their goals (e.g., resting, socializing, exercising, playing).

Figure 8. Compatibility-related park scenes used as visual stimuli: Garden A (gazebo/jogging track) and Garden B (playground).

This pattern supports the congruence perspective in which stress can arise when needs and environmental supports do not match; conversely, recovery is supported when facilities enable desired activities (Stokols, 1979; Evans & Cohen, 1987). Facilities such as gazebos, tracks, and playgrounds may therefore strengthen restorative outcomes by enabling comfortable social use and activity choices (Chiesura, 2006; Grahn, 2009; Irvine, 2013; Evered, 2016).

3.7 Psychological Responses After Visiting the Park (Qualitative Excerpts + Quantitative Coding Results)

To understand what students experienced psychologically, a content analysis was conducted on students' open-ended descriptions of feelings and effects after being in the park. Coding proceeded from open coding (keyword identification) to categorization of responses.

3.7.1 Qualitative excerpts

The following excerpts illustrate common response patterns:

a) "*Enjoyable, refreshing from routines. Felt happy and less stressed*." (Student 4)
b) "*Mind feels clearer, less stress. A moment to forget pressures at work or other life issues*." (Student 41)
c) "*Reduced stress, feeling relaxed and calm, especially when visiting alone.*" (Student 69)
d) "*Calm, refreshed, clearer thoughts. Could reflect on what needs to be done next (finding solutions), and felt happy.*" (Student 135)

Across excerpts, recurring keywords included *"less stress," "calm," "refreshed," "clearer mind," and "happy,"* indicating both affective and cognitive restoration.

3.7.2 Quantitative distribution of coded response categories

Coded responses were grouped into response categories (e.g., affective, interpretative, cognitive, evaluative). The distribution shows that affective responses were most frequent across both gardens, followed by interpretative responses (i.e., students' meaning-making by comparing past and present states).

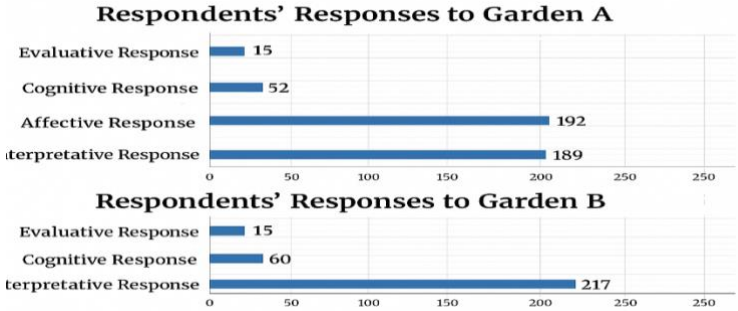

Figure 9. Students' responses after visiting Garden A and Garden B, by response category.

This pattern suggests that students' restorative experience is expressed primarily as emotional improvement (e.g., calmness, happiness, reduced stress), with a secondary layer of interpretation in which students reflect on changes in their condition after visiting the park.

3.8 Physical Elements Influencing Human Responses

After identifying psychological responses, the analysis examined which physical elements students explicitly mentioned as contributing to restoration. Students provided descriptive statements about features that supported comfort, calmness, and enjoyment. Content analysis again proceeded from open coding to categorization. In total, 873 keywords were identified for Garden A and grouped into five categories, while 917 keywords were identified for Garden B and grouped into four categories.

3.8.1 Quantitative distribution of physical element categories

Both gardens shared core categories: vegetation, supporting facilities, landscape furniture, and hardscape. Vegetation had the highest frequency in both gardens, indicating that students most often attributed restorative experience to green elements. In Garden A, water features emerged as an additional category and ranked second after vegetation.

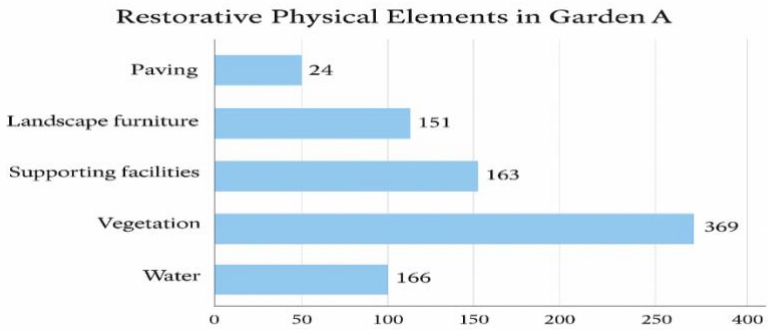

Figure 10. Frequency distribution of restorative physical element categories in Garden A (coded content analysis).

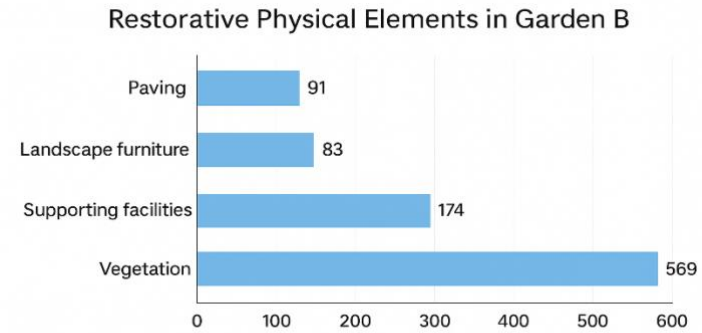

Figure 11. Frequency distribution of restorative physical element categories in Garden B (coded content analysis).

3.8.2 Subcategory patterns within physical elements

A finer breakdown shows which specific features were most salient. In Garden A, high-frequency subcategories included dense/shaded trees, water, and supporting facilities (e.g., gazebos and seating areas). In Garden B, vegetation remained dominant, with flowers and trees as the strongest subcategories, followed by supporting facilities such as the playground.

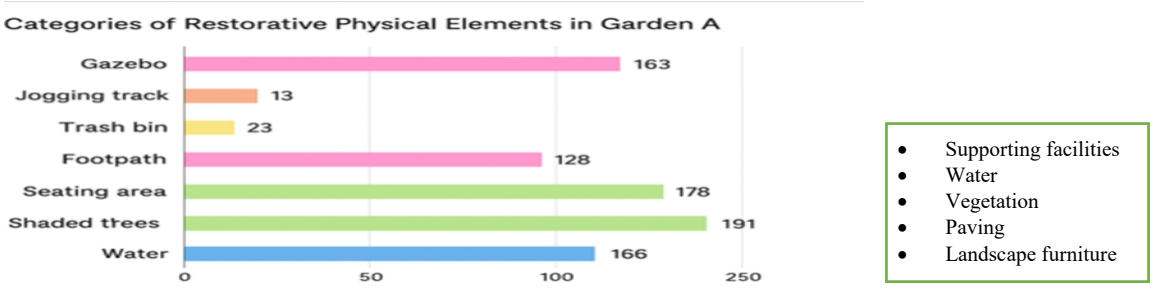

Figure 12. Subcategories of restorative physical elements in Garden A were identified from students' responses (coded keywords).

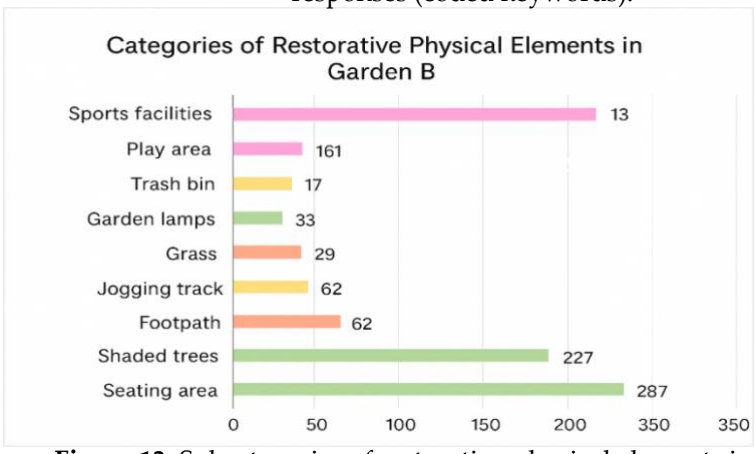

Figure 13. Subcategories of restorative physical elements in Garden B identified from students' responses (coded keywords).

Taken together, these results indicate that restorative experience is anchored in a combination of natural elements (especially vegetation, and water where available) and activity-supporting infrastructure (seating, gazebo, play area, paths). This complements the ART findings: vegetation and water support Being Away and Fascination, while legible paths, seating, and functional facilities support Extent and Compatibility

Discussion

Taken together, the patterns of use, perceived restrictiveness, and on-site attributes suggest that the school gardens function as everyday micro-restorative settings. Students appear to use brief windows in the school day, especially break periods, to down-regulate stress and reenter attention. This interpretation is consistent with evidence that accessible nearby greenery can support short, repeatable recovery episodes in daily routines, including in school-like settings and other everyday environments (Chiesura, 2004; Kelz et al., 2015; Twohig-Bennett & Jones, 2018).

The restorative interpretation is theoretically anchored in Attention Restoration Theory (ART) and its operationalization through perceived restorativeness measures such as the Perceived Restorativeness Scale (PRS). ART proposes that environments supporting *Being Away, Fascination, Extent,* and *Compatibility* facilitate recovery from directed attention fatigue, and systematic evidence reviews show consistent links between exposure to natural environments and attentional restoration outcomes. In this study, students' stated relaxation motive and affective reports (e.g., calmer, less stressed, happier, clearer mind) are coherent with this ART logic, while the photo-based stimulus task provides a PRS-aligned way of eliciting perceived restorative affordances in an applied school context (Kaplan, 1995; Hartig et al., 1997; Hartig et al., 2003; Ohly et al., 2016).

Importantly, what this study adds to the Indonesian school context is a practice-near mapping between students' everyday school-garden use, their ART-patterned perceptions, and the specific

design cues they notice. For *Being Away*, students preferred scenes characterized by dense canopy and pavilion-like spatial "rooms", which aligns with work showing that small green spaces with vegetation structure and enclosure can predict perceived restoration. For *Fascination*, salient water and flowering displays match findings that "blue space" and visually engaging natural features can elevate perceived restorativeness and positive affect. For *Extent*, legible paths and seating fit evidence that coherent, exportable layouts support effortless cognitive "unfolding" of a scene. For *Compatibility*, activity-supportive features such as gazebos, short tracks, and play areas align with the idea that restoration improves when environmental affordances fit users' goals and constraints (Nordh et al., 2009; White et al., 2010; Herzog et al., 2003; Grahn & Stigsdotter, 2010).

From an education perspective, students' reported outcomes also connect to a broader evidence base linking greener learning environments to attention and cognitive functioning. Experimental and quasi-experimental studies indicate that exposure to green views can support recovery from stress and mental fatigue in school populations, and longitudinal work links greener surroundings with gains in cognitive development indicators. In addition, controlled studies show cognitive benefits of interacting with nature in ways consistent with restoration mechanisms (Li & Sullivan, 2016; Dadvand et al., 2015; Berman et al., 2008).

A notable contextual layer in this study is that garden visits were often social, with many students visiting with friends. This suggests the gardens may be restorative not only through attentional mechanisms, but also through socially supportive routines such as shared enjoyment, belonging, and informal peer regulation of stress. Such socially mediated benefits are consistent with qualitative evidence that users conceptualise green space as a health resource through both emotional and relational effects (Irvine et al., 2013; Chiesura, 2004).

At the same time, the interpretation should avoid overgeneralization beyond this sample and cross-sectional design. Several alternative explanations and contextual factors may also shape the pattern of responses. The concentration of use during breaks could reflect timetable constraints rather than purely restorative preference. Preferences for shaded, tree-dense scenes may partly reflect thermal comfort and sun avoidance in a tropical climate. Cultural norms that emphasize togetherness may contribute to the predominance of friend-based visits. Proximity to canteens, supervision practices, or school rules may also influence where and when students go. These factors do not contradict ART, but they suggest that restoration is likely produced by an interaction between restorative affordances and the practical realities of Indonesian school routines.

The implications are therefore best framed as design-for-fit within school schedules and student support systems. For school design, the evidence supports prioritizing tree canopy and shade, clear paths, and ample seating, plus small activity-supportive micro-spaces that work within short break windows. For learning environments, gardens can be treated as low-cost infrastructure that supports attentional reset between classes rather than as occasional enrichment. For student support systems, routine access to these spaces can complement counselling and wellbeing initiatives by providing an everyday, non-stigmatizing regulation setting. These implications are consistent with evidence that schoolyard redesign and targeted greening interventions can yield measurable restorative benefits (Kelz et al., 2015; Twohig-Bennett & Jones, 2018).

4. CONCLUSION

This study contributes to school-greening scholarship by demonstrating that students' recovery experiences are not merely general positive impressions, but are systematically aligned with PRS-informed perceptions of restorativeness and with identifiable garden attributes. In this authentic school context, students' accounts and coded responses indicate that brief, repeated garden visits are associated with improved affective states and attentional readiness, consistent with the ART logic operationalized through the PRS dimensions of Being Away, Fascination, Extent, and Compatibility. Importantly, the findings clarify that students read specific design cues as supportive of restoration, offering an applied bridge between theory and everyday school practice.

From an educational perspective, the results suggest that school gardens can function as routine learning-support environments rather than optional amenities. Students' reports of calmer affect, reduced stress, and clearer thinking after spending time in the garden imply that these spaces may support emotional regulation and attentional reset during the school day, particularly within short break windows. In this sense, gardens can be understood as part of the broader ecology of learning environments that shape students' readiness to re-engage with classroom demands and that can complement existing approaches to student well-being. The findings also have direct relevance for design and policy. At the design level, the evidence points to a pragmatic brief that schools can implement incrementally: strengthen shade and thermal comfort through canopy and planting, maintain clear and legible circulation to support effortless exploration, and provide small purpose-friendly niches through seating, gazebos, and activity-supportive micro-spaces that students can use efficiently during breaks. At the policy level, positioning gardens as core learning-support infrastructure reframes greening from aesthetic enhancement to an evidence-informed component of student support systems, with plausible spillovers for school climate and equitable access to restorative micro-moments. Because many improvements can be integrated into routine maintenance cycles, the pathway from evidence to action does not necessarily require large capital projects.

These conclusions should be interpreted with appropriate caution. The study relied on a non-probability sample, which limits representativeness, and the cross-sectional design prevents causal inference and restricts generalization beyond comparable school contexts. In addition, the primary outcomes were based on self-reported perceptions and descriptions, which may be shaped by timing in the school schedule, peer companionship, or other contextual influences that are not fully disentangled in the present design. Future research should therefore strengthen inference and clarify mechanisms through longitudinal and intervention-based approaches. Multi-site longitudinal designs can test the durability of benefits and identify subgroup patterns linked to schedules and access. Experimental or quasi-experimental interventions, such as adding shade, seating, or wayfinding features using staggered or stepped implementation, can evaluate causal impacts of specific design changes. Finally, incorporating objective indicators alongside PRS-based measures, including behavioural use data, environmental exposure metrics (e.g., canopy, noise, temperature, air quality), and physiological proxies, would provide stronger triangulation and a more precise account of how garden features translate into restoration and learning readiness over time.

Conflicts of Interest: The authors declare no conflict of interest.

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