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The Restorative Effect of the Presence of Greenery on the Classroom in Children's Cognitive Performance

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Abstract: Studies developed in a scholar context report a restorative effect of nature on human beings, specifically in terms of the psychological recovery from attention fatigue and restored mental resources that were previously spent in activities that require attention. Studies usually compare the performance of children in schools with or without access to green spaces. In this study, the effect of introducing greenery into the classroom context was compared across time. The experiment was developed in two primary schools with pupils in different socioeconomic contexts, at three moments: before introducing an artificial green wall into the classroom, one month later, and one month after the introduction of vegetable pots. Results showed a significant increase in sustained and selective attention, and work memory between the experimental and the control group, notably in the third moment when vegetable pots were introduced. In the second moment (green walls), only the work memory (tested with the inversed number) showed a significant effect. Theoretical and practical implications are discussed in terms of nature's role both in terms of natural and artificial elements and the cumulative effect of direct interaction with natural elements.

Keywords: restorative effect; greenery; classroom; children; cognitive performance

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1. Introduction

Schools are the environment where children spend more time indoors. In schools, children are expected to keep directed attention during long periods in a context of high cognitive demand. Directed attention is fundamental to the development of children's daily activities in the school context [1,2]. The school conditions may affect children, especially primary school children, who are more susceptible to having direct attention fatigue and lack of focus in school activities [3]. The attention restoration theory (ART) suggests that restorative environments, such as the exposure to natural environments, stimulate involuntary attention. These restorative environments help reduce tiredness, allowing individuals to restore their capacities of directed attention during learning activities [4,5]. ART is the theory that has most influenced research regarding the restorative effect of nature on humans' well-being [6]. A core concept in this theory is that human beings have limited cognitive capacities, namely, limited directed attention, particularly when the point of attention is not of interest to the subject [4]. So, in order to maintain directed attention, competing stimulus must be blocked through the central executive mechanism. Although, prolonging the use of this process will lead to directed attention fatigue (DAF).

Directed attention is involved in most of our daily activities. It is voluntary and requires a mental effort to block and ignore distractions. The attention restoration theory focuses on the psychological processes of recovery from mental fatigue and the cognitive resources spent on daily activities. Environments that do not require directed attention allow the subject to recover from this mental fatigue [7]. ART predicts that certain environments

can contribute to fight DAF when the person–environment relationship has four qualities: Fascination, or the ability to attract the subject's attention without having to make an effort; Extension or Connection, which is the feeling of connection to the environment; Compatibility between the subject's interests and the characteristics of the environment; and Being away, from daily activities and obligations. These characteristics are present in multiple environments, of which the most outstanding are natural or naturalized environments [5], including the physical presence or representation of natural elements.

According to the ART theory, nature has these four characteristics which make it restorative. Later studies based on ART developed questionnaires to assess restorative capacity. These have found that environments that score high in these four dimensions have restorative capacity both in adults [8,9] and children [10].

Contact with nature for restorative purposes is usually considered as contact with some natural elements, such as vegetation, water and even the blue sky [11]. The period required for the restorative effect is not well specified in the literature. Even very short periods of time may have restorative effects of micro-restoration [12], as during school recess.

1.1. Literature Review

Recent studies have highlighted the importance of green spaces for children's development and well-being [13]. A systematic literature review [14] showed that school performance is positively influenced by exposure to natural environments. Namely, the presence of outdoor green spaces in the school context contributes to increased concentration and attention [15–17], even in children with attention-deficit [18]. It improves cognitive development [19], reduces stress and contributes to the restoration of mental fatigue associated with the learning process [20–22]. Also, it improves student self-discipline [23] and classroom engagement [24]. These are important functions for students to retain academic content and thus obtain better academic results [16,25].

Previous studies show that not only physical access to outdoor green spaces, but also views of nature from windows, help children to concentrate and maintain directed attention in different contexts [16,26]. For example, two studies in high schools in the United States found that the views of nature from the classroom were associated with increased standardized test scores and graduation rates [26], and scored higher on attention tasks and recovered more quickly from a stressful experience when compared to students in classrooms with a barren view [16].

Most studies seek to understand the impact of outdoor green spaces on school premises on sustained attention [17] and working memory [19] and concentration [15]. For example, [19] found an improvement in sustained attention and working memory in primary school students attending schools with outdoor green spaces. It was also found that they were more focused in areas with trees and shrubs [17], and showed greater ability to concentrate in preschools with outdoor green spaces [15].

Focusing on students' results (performance), a study suggested that contact with outdoor green spaces during school time is significantly associated with better results on tasks that require directed attention [27]. The presence of vegetation around the school premises is also associated with improvements in standardized test scores on math and reading [28,29].

A study performed in a public school for nine years (2006–2014) involving 27,493 students between the third and the tenth grade found a positive and significant association between schools' surrounding open green areas and academic performance, using Composite Performance Index (CPI) as well as the percentage of students who scored "Proficient and Higher" (AP%) in the examination. This positive relationship between schools' surrounding open green areas and academic performance was consistent among populations with different sociodemographic characteristics [30].

Few studies have yet been performed on the introduction of indoor greenery [12,31,32] (e.g., green walls [3,33]) in classrooms. However, in the professional context, it was found that in rooms without windows, the presence of plants in pots contributed to the reduction

of stress and increased productivity [34]. Also, workers had greater job satisfaction in spaces with plants [35]. A literature review on experimental studies on the psychological benefits of indoor plants suggests that indoor plants can provide psychological benefits [36], such as reducing stress and increasing pain tolerance. However, the benefits seem to depend on the context characteristics in which the indoor plants are found (e.g., rooms with or without windows) and on the characteristics of the analysed group.

There are also few empirical studies regarding the benefits of introducing plants in school settings [31]. The existing ones are mainly focused on high school students [12,32,37–39]. These studies seek to understand the impact of introducing plants in classrooms on students' physical health [39]; performance [37,38], stress levels [32]; directed attention levels [40] and behaviour [12]. In a quasi-experimental study performed in a high school, ref. [12] compared the introduction of six different plant species in the back of the classroom (experimental group) with rooms where nothing was introduced (control group). The results showed that the experimental group had significantly higher scores in preference and comfort perception and fewer hours of sick leave and punishment records, compared to the control group. A study performed with junior high school students found that the introduction of three large plants in the classroom, in two of the three schools assessed, led to students' increased scores in spelling and mathematics [37]. Also, among high school students, it was found that in addition to performance, students had a more positive perception of instructors, both in terms of enthusiasm and organization. These differences were particularly evident in rooms that had no windows [38]. The introduction of ornamental plants in classrooms of high school students aged 16 and 17 years old, in a quasi-experimental study, revealed that the presence of plants improved the physical space perception (e.g., appropriate place for classes' and "relaxed place"), and contributes to the reduction of stress levels among students, namely, reducing the number of visits to the infirmary [32]. Focusing on the pre-school [41] shows the relevance of indoor plants in their contribution to the increase in children's attention in pre-schools.

Regarding the restorative impact of green walls in classrooms, only one study was identified [33]. The authors assessed the impact of a green wall with live plants placed in the classroom on two primary school children with an average age of nine years, using a prospective design with baseline measurements and follow-ups at two and four months. Cognitive performance, well-being and classroom evaluation were measured. The results showed that the experimental group where the green walls were placed showed better results in selective attention (measured with the Sky Search task), but there were no significant differences for the processing speed (measured with the DLST- Digital Letter Substitution Test), nor for the self-assessment of well-being. The presence of green walls positively influenced the children's assessment of classrooms. Assuming the positive effect of green walls [42], recently [3] proposed a project-based methodology that foresees the inclusion of green walls in the school context associated with environmental education programs, intending to increase student involvement with environmental issues, but assuming its positive impact on school success.

1.2. Objectives

In this paper, we aim to assess the impact of the introduction of greenery (natural and artificial) in children´s psychological restoration, including them passively and actively in the classroom, in schools with the absence of outdoor green spaces. For this purpose, two studies were carried out evaluating whether children´s sustained and selective attention, their working memory, their satisfaction/perception of the classroom and their perception of greenery in the classroom design increase over time. In the first study, two groups of children were compared (experimental group and control group), in which the control group was assessed at the same time but had no intervention in the classroom. In the second study, also with third-year students, two schools were compared with children from different sociodemographic contexts (low and medium), both with the same type

of interventions in the classroom as in the first study. No control group was used in this second study.

2. Methodology

2.1. Study 1

Study 1 aimed to test the impact of introducing greenery into the classroom (natural and artificial), analysing the attention restoration and classroom satisfaction/perception of children in the third-year of school (first cycle). Thus, the quasi-experimental design assessed two attention components: sustained and selective attention and working memory, as well as the degree of satisfaction with the classroom. Two groups were considered: the group that was submitted to the two interventions in the classroom (green wall and vegetable pots), and the control group in which no change occurred in their classroom, bearing in mind that the same measures were used in the three assessment moments (T1, T2, T3). The control group allows perceiving if the improvement between moments (T1–T2 and T2–T3) is due to the measuring learning processes or the intervention. As shown in Figure 1, the study was developed in three moments of evaluation and two interventions in the classroom. Thus, the first intervention was based on the placement of an artificial green wall, 150 cm wide and 250 cm in height, in the classroom window area (Figure 2a). The second intervention consisted of an activity in which the children planted one lettuce in a pot with their teacher (Figure 2b). Then, each child was responsible for maintaining its own lettuce, namely watering it and monitoring its growth. By the end of the experiment, each child had one lettuce, which they would harvest and take home. The first assessment was carried out before the interventions were carried out (T1). The second assessment took place approximately one month after the introduction of the green wall (T2). The third assessment took place approximately one month after carrying out the lettuce planting (T3) and two months after the introduction of the green wall (T2).

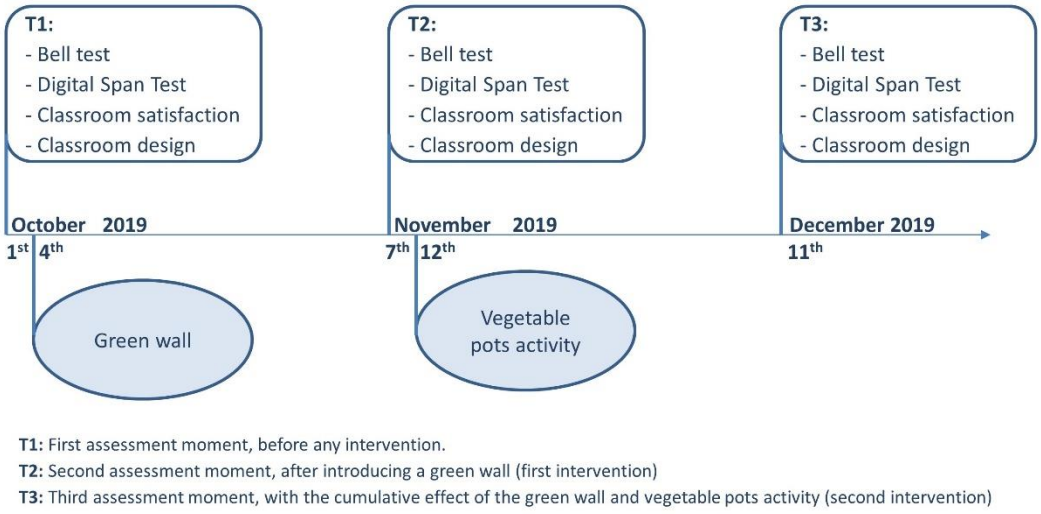

Figure 1. Methodology diagram.

2.1.1. Hypotheses

A group of hypotheses were established in order to evaluate children´s sustained and selective attention, their working memory, their satisfaction/perception of the classroom and their perception of greenery in the classroom design. The analysed hypotheses were organized as follows:

Hypotheses 1. *Children's sustained and selective attention will be greater in T2 (vs. T1), after the introduction of an artificial green wall in the classroom window (vs. non-green wall—control group);*

Hypotheses 2. *Children's sustained and selective attention will be greater in T3 (vs. T1 and T2), after the introduction of an activity with vegetable pots in the classroom (vs. non-vegetable pots—control group)*

Hypotheses 3. *Children's working memory will be greater in T2 (vs. T1), after the introduction of an artificial green wall in the classroom window (vs. non-green wall—control group);*

Hypotheses 4. *Children's working memory will be greater in T3 (vs. T1 and T2), after the introduction of an activity with vegetable pots in the classroom (vs. non-green wall—control group);*

Hypotheses 5. *Children's classroom evaluation will be greater in T2 (vs. T1), after the introduction of an artificial green wall in the classroom window (vs. non-green wall—control group);*

Hypotheses 6. *Children's classroom evaluation will be greater in T3 (vs. T1 and T2), after the introduction of an activity with vegetable pots in the classroom (vs. non-green wall—control group);*

Hypotheses 7. *Children in the experimental group represent more natural elements in the classroom drawing in T3 than children in the control group, considering both elements introduced in the classroom (green wall and vegetable pots) and also other pre-existing natural elements not introduced along with the study (ex: flower pots, designs with flowers, etc.).*

2.1.2. Participants and Contexts

In this first study, four classrooms with students of primary school (1st cycle) in the third year were evaluated, from which two classrooms were selected randomly as the control group and two others as the experimental group. The final sample consisted of 95 students, from which 45 students belonged to the experimental group and 40 to the control group. Some answers had to be excluded from each group due to the lack of answers in all assessment moments, which explains the sample difference between groups. These students are from a public school in Lisbon located in an area considered middle class. Each group consisted of two classrooms. All classrooms were identical, located along the same corridor on the first floor of the building, including windows with a view to the playground. The school was selected for not having any outdoor green space, with a playground being surrounded by buildings.

a) b)

Figure 2. (**a**) Artificial green wall applied to the classroom window; (**b**) Activity with lettuce pots in the classroom.

2.1.3. Measurements

The following four measurements were performed in the three evaluation moments:

(1) Sustainable and selective attention—The Bell test [43] is a standardized measure of selective and sustained attention, suitable for primary school children. The test consists of an A4 sheet, filled with 280 black drawings of different symbols (e.g., tree, horse, apple, bell), of which 35 are bells. The task of attention is to mark all the bells with a pencil in a period of 120s. The attention score is the total number of marked bells, ranging from 0 to 35. Badly marked symbols are not considered;

(2) Working memory—Digital span test was used to evaluate working memory (in WISC-IV, Wechsler intelligence scale for children). It is a standardized measure for attention and concentration, connected with the maintenance of information and working memory. This task is originally administered individually, being here collectively administered in the classroom context (as previously used by [6]). Children are read a series of numbers, and then write them on a sheet of paper (instead of repeating them aloud as in the original version). The set of digits that must be registered in the same order (DSF) as shown is composed of five series of digits (from 2 to 6 digits) and the registration in reverse order (DSB) is composed of four series of digits (from 2 to 5 digits). As in the original task, the total score is calculated as the sum of the series accurately written (DSF- Digital span forward and DSB- Digital span backward);
(3) Classroom Evaluation—three questions were asked to evaluate the classroom ("do you like your classroom?", "Do you think your classroom is beautiful?", "Do you think your classroom is cheerful?"). The students answered a 6-point graphical scale (emotion mood scale), which presented drawings of faces that varied between a big smile or a crying face. Cronbach's alpha of the scale revealed a value of 0.867, which is considered a good value;
(4) Classroom drawing—Students were asked to draw a picture of their classroom on a white A4 sheet for 20 min. The purpose of this request was to verify in each of the evaluation moments whether the children included elements of greenery in the drawing, namely, whether in T2 they included the green wall, and in T3 they included the green wall and vegetable pots. The evaluation of the drawings was carried out by two researchers, which identified the green elements present in the drawing and categorized them into three categories: green wall, vegetable pots, other elements of greenery (e.g., vases, flowerpots, drawings or pictures with flowers).

2.1.4. Procedure

This study applied a within-subjects and between-subjects design (3 X (T1, T2, T3) X 2X (experimental group/control group). The control group had no intervention, while the experimental group had two interventions as described in Figure 1. One is the introduction of an artificial green wall and the other is the introduction of an activity with vegetable pots. All subjects were evaluated in three moments considering the cumulative effect of the interventions. All children in the classroom took the bell test, the digital span test, the classroom evaluation and the end of the classroom design.

2.2. Study 2

Study 2 aimed to analyse the impact of two interventions in the classroom, following the same procedure as Study 1, comparing two schools with different socioeconomic contexts. This study does not involve a control group, as it compares intervention results from groups differing in their socioeconomic status. The methodology applied to Study 2 is the same as Study 1, both in terms of the measures used and procedure. The interventions and evaluations were carried out at the same time.

2.2.1. Hypotheses

The hypotheses of this study are identical to the ones presented in Study 1, this time considering the obtained results for both groups. These hypotheses were established to evaluate children´s sustained and selective attention, their working memory, their satisfaction/perception of the classroom and their perception of greenery in the classroom design.

2.2.2. Participants and Contexts

In the second study, four classrooms from two public primary schools in Lisbon with students of primary school (1st cycle) in the third year were evaluated. The group includes 45 students from a school located in a middle-class neighbourhood (experimental group of Study 1) and 30 students from a school, close to the previous one, but located in a

social housing neighbourhood with a low-income population. Each group consisted of two classrooms. Some answers had to be excluded from each group due to the lack of answers in all assessment moments, which explains the sample difference between groups. Both schools were selected for not having any outdoor green space.

3. Results

To test the hypotheses, a one-way analysis of variance (ANOVA) of repeated measurements was performed to identify the pairs of measures that differ from each other. For the interaction between factors and evaluative moments, multiple comparisons of averages with Bonferroni correction were performed according to (Maroco 2007).

3.1. Study 1

3.1.1. H1 and H2—Sustained and Selective Attention

The repeated measures showed significant differences between the experimental group (M = 29.6) and the control group (M = 27.9) (F (1.83) = 6.420, p = 0.013, observed power = 0.707). Regarding the evolution of scores were observed significant differences in the three moments (F (2166) = 76,691, p = 0.000, observed power = 1000). As shown in Figure 3, the scores for both groups increased, from moment to moment.

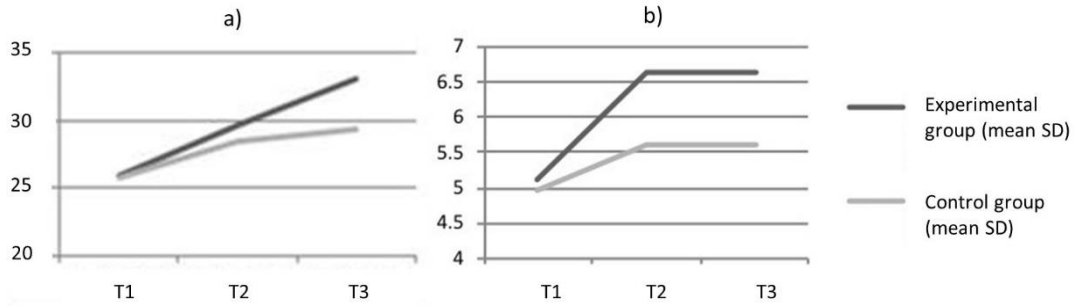

Figure 3. Mean scores of both groups in each moment (T) for: (**a**) sustained and selective attention; (**b**) working memory.

Finally, the intervention effect, namely the comparison between the experimental group and the control group, reveals significant differences (F (2166) = 8.659, p = 0.000, observed power = 0.967). As shown in Figure 3 and Table 1, for T3, the intervention in the classroom leads to significantly higher values in sustained and selective attention compared to children who had no intervention. However, this difference is not as significant for T2. This means that H1 (the impact of the green wall on sustained and selective attention) is unverified. Although H2, considering the two interventions (green wall and vegetable pots), has a positive effect on sustained and selective attention (Table 1).

Table 1. Means, standard deviation and Student t of dependent variables in each moment (T).

	Moment	Experimental Group (Mean, SD)	Control Group (Mean, SD)	T	Sig
Sustained selective attention	T1	26.00	25.75	0.242	0.810
	T2	29.69	28.53	1.527	0.131
	T3	33.00	29.30	5.560	0.000
Working memory	T1	5.13	4.95	0.671	0.504
	T2	6.62	5.60	3.594	0.001
	T3	6.64	5.62	3.126	0.003
Classroom satisfaction	T1	16.20	15.37	1.227	0.223
	T2	16.00	14.20	2.116	0.037
	T3	17.18	14.50	3.626	0.000

As expected, there were no significant differences at moment T1, which demonstrates that the groups were similar at the beginning, and the differences observed in T2 and T3 were a result of the interventions.

3.1.2. H3 and H4—Working Memory

The repeated measures showed significant differences between the experimental group (M = 6.13) and the control group (M = 5.39) (F (1.83) = 10.604, $p = 0.002$, observed power = 0.896). Regarding the evolution of scores, there are significant differences in the three moments (F (2166) = 30,212, $p = 0.000$, observed power = 1000). As observed in Figure 3 and Table 2, the scores increased significantly between T1 and T2 for the experimental group and marginally significant for the control group but did not increase significantly between moments 2 and 3.

Table 2. Means, standard deviation and F, between moments (T) for each group.

	Group	T1	T2	T3	F	Sig
Sustained selective attention	Experimental Group	26.00_A	29.69_B	33.00_C	91.889	0.000
	Control Group	25.75_A	28.53_B	29.30_B	14.142	0.000
Working memory	Experimental Group	5.13_A	6.62_B	6.64_B	40.979	0.000
	Control Group	4.95_a	5.60_b *	5.62_b	4.194	0.019
Classroom satisfaction	Experimental Group	16.20	16.00_a *	17.18_b *	4.415	0.015
	Control Group	15.37	14.20	14.50	2.759	0.070

Note: Means in the same row with different subscripts are significantly different at the $p < 0.05$ level and the subscripts with capital letters are significantly different at the $p < 0.001$. * Significantly different at $p > 0.09$.

Finally, the effect of the intervention, this means the comparison between the experimental group and the control group, reveals significant differences (F (2166) = 4530, $p = 0.012$, observed power = 0.766). As shown in Figure 4 and Table 1, the intervention in the classroom for T2 and T3 leads to significantly higher values in working memory compared to children who had no intervention, but not for T1. This means that H3 and H4 are verified (Table 1). Therefore, the green wall presence contributes to a significant increase in the working memory in the experimental group compared to the control group. This effect remained at moment T3 but did not increase significantly.

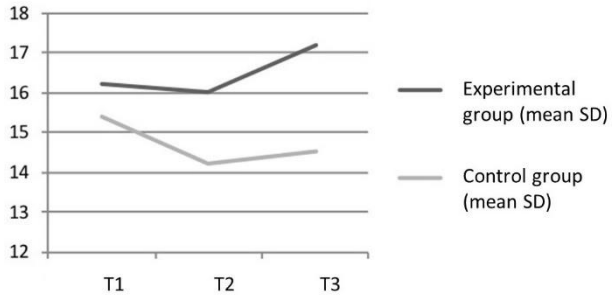

Figure 4. Satisfaction mean scores (H5 and H6).

As expected, there are no significant differences between groups for moment T1. This demonstrates that both groups were similar at the beginning, showing differences in T2 and T3 due to the intervention.

Thus, it can be said that H3 was confirmed, but H4 was only partially confirmed. This means that there are differences between moment T1 and T2, and between T1 and T3, but not between T2 and T3. However, scores remain significantly higher for the experimental group in comparison with the control group.

3.1.3. H5 and H6—Satisfaction

The repeated measures showed significant differences between the experimental group (M = 16.46) and the control group (M = 14.70) (F (1.83) = 7.329, p = 0.008, observed power = 0.763). Regarding the scores' evolution, there are significant differences in the three moments (F (2.166) = 3.077, p = 0.049, observed power = 0.587). However, a post hoc analysis with Bonferroni correction, as shown in Figure 4 and Table 2, demonstrates that there are no significant differences between T1 and T3, and the differences between T1 and T2 (p = 0.76) and T2 and T3 (p = 0.57) are only marginally significant. However, it appears that while in the experimental group there is a small decrease between T1 and T2 and an increase in T3 to values above T1, in the control group there is a decrease between T1 and T2, keeping T3 well below the T1 values.

Finally, the effect of the intervention, which is represented by the comparison between the experimental group and the control group, reveals significant differences (F (2.166) = 3.882, p = 0.022, observed power = 0.695). As shown in Figure 5 and Table 1, the intervention in the classroom leads to significantly higher values in classroom satisfaction/perception compared to children who had no intervention for T2 and T3, but not for the T1. Therefore, H3 and H4 are verified (Table 1). This means that the green wall presence contributes to a significant increase in classroom satisfaction in the experimental group compared to the control group, which remained at moment 3, but did not increase significantly.

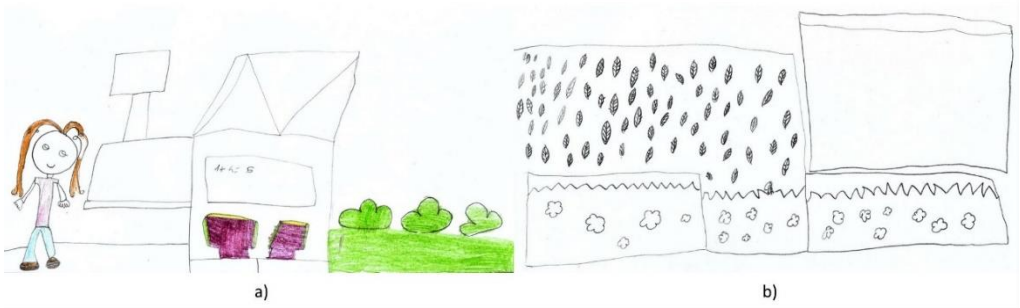

Figure 5. Presence of natural elements in classroom drawings: (**a**) Drawing with lettuce pots; (**b**) Drawing with green wall and lettuce pots.

As expected, there were no significant differences for the moment T1, which shows that the groups at the beginning were similar, with the differences observed in T2 and T3 due to the intervention.

Thus, we can say that H5 and H6 are marginally confirmed. In fact, the differences between the three moments are only marginally significant. However, the scores are significantly higher for the experimental group than for the control group.

3.1.4. Classroom Drawing—Presence of Natural Elements

Finally, the last hypothesis predicted that, in the experimental group, the classroom drawings would present not only the elements that were introduced but also a greater number of greenery elements that were not introduced in the classroom by the experience (Figure 5). The results shown in Table 3 demonstrate that the green wall presence was manifested only in a residual form in T2, and a little higher in T3. In contrast, the presence of vegetable pots was more intense, with 44% of children in the experimental group including these elements in their drawings. Perhaps the most interesting result is that T3 also increased the presence of other greenery.

Table 3. Green elements present in the classroom design in the three evaluation moments (T).

Moment	Classroom Satisfaction	Experimental Group	Control Group
T1	Other green elements	10 (22%)	7 (17.5%)
T2	Other green elements	11 (24%)	5 (12.5)
	Green wall	1 (2%)	0
T3	Other green elements	16 (36%)	3 (7.5%)
	Green wall	5 (11%)	0
	Vegetable pots	20 (44%)	0

3.2. Study 2

3.2.1. H1 and H2—Sustained and Selective Attention

The repeated measures showed that there are no significant differences between the medium level group (M = 29.6) and the low sociodemographic group (M = 29.1) (F (1.73) = 0.366, p = 0.547, observed power = 1000). Regarding the score's evolution, there are significant differences in the three moments (F (2146) = 86,063, p = 0.000, observed power = 1000). As shown in Figure 6 and Table 4, the scores for both groups increased significantly from moment to moment for the three groups. This confirms H1 and H2.

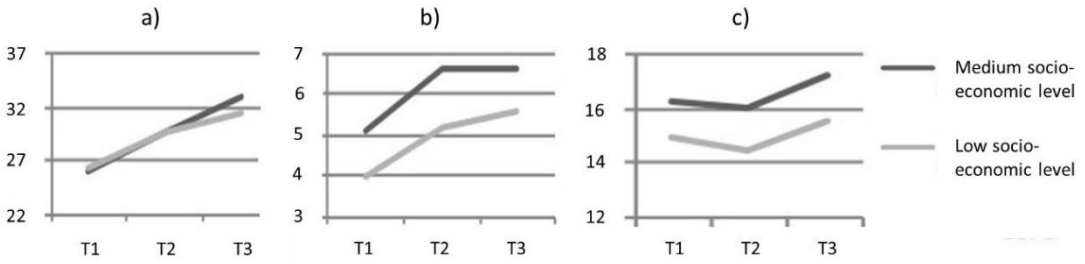

Figure 6. Mean scores for each moment (T) of: (**a**) sustained and selective attention; (**b**) working memory; (**c**) classroom satisfaction.

Table 4. Means, standard deviation and "F" of sustained selective attention, working memory and classroom satisfaction scores in Study 2 (numbers and inverse numbers) between moments (T) and for each group.

	Groups	T1	T2	T3	F	Sig
Sustained selective attention	Middle-class school	26.00_A	29.69_B	33.00_C	91.889	0.000
	Low-class school	26.37_A	29.63_B	31.33_C	19.302	0.000
Working memory	Middle-class school	5.13_A	6.62_B	6.64_B	40.979	0.000
	Low-class school	3.97_A	5.17_B	5.60_B	15.371	0.000
Classroom satisfaction	Middle-class school	16.2	16.00_a *	17.18_b *	4.415	0.015
	Low-class school	14.97	14.47	15.57	1.006	0.372

Note: Means in the same row with different superscripts are significantly different at the $p < 0.05$ level and the subscripts with capital letters are significantly different at the $p < 0.001$. * Significantly different at $p > 0.09$.

Finally, the effect of the intervention, in the increase of the scores between the group of high and low sociodemographic level reveals that there are no significant differences (F (2146) = 8.659, p = 0.048, observed power = 0.535).

3.2.2. H3 and H4—Working Memory

The repeated measures showed significant differences between the group of medium socioeconomic level (M = 6.13) and the group of low socioeconomic level (M = 4.91) (F (1.73) = 25.954, p = 0.000, observed power = 0.999). Regarding the scores' evolution, there are significant differences in the three moments (F (2148) = 49,425, p = 0.000, observed power = 1000). As observed in Figure 6 and Table 4, the scores increased significantly

between T1 and T2, and also between T1 and T3 for both groups. However, there is no cumulative effect of the two interventions; this means that there are no differences between T2 and T3. So, it can be said that H3 and H4 were verified. Finally, the effect of the intervention between groups (low and medium socioeconomic level) does not reveal significant differences (F (2148) = 4530, p = 0.466, observed power = 0.778). However, when comparing the results between groups for each moment (Table 5), it is possible to find some significative differences between the groups.

Table 5. Means, standard deviation and "t" of sustained selective attention and working memory scores in Study 2 (numbers and inverse numbers) between groups for each moment (T).

	Moment	Middle-Class School (Mean)	Low-Class School (Mean)	t	Sig
Sustained selective attention	T1	26.00	26.37	−0.325	0.746
	T2	29.69	29.63	0.060	0.952
	T3	33.00	31.33	2.722	0.008
Working memory	T1	5.13	3.97	4.226	0.000
	T2	6.62	5.17	4.512	0.000
	T3	6.64	5.60	3.160	0.002
Classroom satisfaction	T1	16.20	14.97	1.464	0.147
	T2	16.00	14.47	1.624	0.109
	T3	17.18	15.57	2.446	0.017

3.2.3. H5 and H6—Satisfaction

The repeated measures showed only marginally significant differences between the experimental group (M = 16.46) and the control group (M = 15.00), (F (1.73) = 4.682, p = 0.060, observed power = 0.570). Regarding the scores' evolution, there are significant differences in the three moments (F (2146) = 4062, p = 0.019, observed power = 0.715). However, a post hoc analysis with Bonferroni correction, as shown in Table 4, demonstrates that there are only marginally significant differences for the group of medium sociodemographic level between T2 and T3. So, it can be said that H5 and H6 have not been verified. Finally, the effect of the intervention reveals that there are no significant differences between groups (low and medium socioeconomic level) (F (2146) = 0.119, p = 0.888, observed power = 0.695). However, when comparing the results between groups for each moment (Table 5), it is possible to find some significative differences between groups.

3.2.4. H7—Classroom Drawing—Presence of Natural Elements

Finally, the last hypothesis predicted that both groups would have more representation of greenery in their classroom drawings in T3 compared to the other moments, related to the interventions (green wall and vegetable pots), and also to other greenery pre-existing in the classroom. The results presented in Table 6 show that for the middle-class group, the presence of the green wall was shown residually in T2, and its presence was slightly higher in T3. In contrast, the presence of vegetable pots was more intense, with 44% of children in the experimental group including these elements in their drawings. For the low-class group, despite the increase in the presence of greenery, this increase was much less expressive. The analysis of the drawings of the children in this group also reveals the presence of fewer elements in general or greater difficulty in identifying these elements in the drawings due to a lower graphic quality.

Table 6. Green elements present in the classroom drawing in both schools, during the three evaluation moments (T).

Moment	Classroom Satisfaction	Medium-Class School	Lower-Class School
T1	Other green elements	10 (22%)	0
T2	Other green elements	11 (24%)	2 (7%)
	Green wall	1 (2%)	3 (10%)
T3	Other green elements	16 (36%)	2 (7%)
	Green wall	5 (11%)	6 (20%)
	Vegetable pots	20 (44%)	10 (33%)

4. Discussion

Generally, the results of both studies confirm the initial hypotheses, that is, greenery in the classroom, both artificial and natural, has a positive impact on sustained and selective attention and working memory. Whereas, in the case of satisfaction, the evidence is marginally significant and only observed in Study 1 with the introduction of vegetable pots.

Sustained and selective attention improved both in the intervention with green walls and with vegetable pots, with a cumulative effect of the introduction of the latter. That is, these results are significant both in Study 1, which makes a comparison between an intervention group and a control group, and in Study 2, which compares different socioeconomic contexts.

Concerning the working memory in both studies, there is an improvement between the T1 and T2 moments which is maintained for moment T3. This effect did not increase with the second intervention, which means that the cumulative effect was not verified. In Study 1, there are significant differences between the experimental group and the control group. As the starting points are the same, it appears that the intervention had a positive effect on group performance. Even when the starting points are different in terms of working memory, as in the case of Study 2, the same evolution is verified, maintaining the difference between groups.

This confirms the results obtained in other studies concerning the impact of the presence of green elements, both concerning sustained and selective attention and working memory [17,19]. However, the studies presented here are distinguished by the fact that the green elements are indoors and include artificial and natural elements.

There is no scientific evidence in the literature on the distinction between the impact of artificial and natural greenery (live). Even though, studies indicate that not only the contact with vegetation has a restorative effect on students in the school environment [6,20,31,44], but also passive interaction, including the visualization of natural elements in the surrounding environment, can have a restorative effect on human beings [45]. In this study, it is verified that even the presence of artificial greenery (passive) and small greenery showed an impact in both studies. This result would be expected, considering that initial studies on the restorative effects [46] already showed a positive impact with the simple observation of images with natural environments. However, we are not aware of any studies that have obtained this result in the context of primary schools on directed attention and working memory. In this sense, this study is, on the one hand, innovative, but on the other, it needs to be replicated against other conditions, including larger samples.

The second study sought to understand the impact of green elements on children from different socioeconomic backgrounds. The results show that the impact is similar, even though children of lower economic level demonstrate initial lower values on working memory. Also, concerning the impact of the socioeconomic level, studies exploring this factor are still unknown.

This study did not have as a purpose the comparison of artificial and natural greenery. It observed the cumulative effect between the two interventions, not allowing to isolate the contribution of vegetable pots, as being natural (live) elements, associated to the fact that they also represent an active interaction with greenery. This means, as [31] identified,

both active and passive interaction with greenery increases attention restoration. However, active interaction mode shows significantly greater impacts compared to passive interaction mode in previous studies [47]. A review done by the authors demonstrated the value of gardening in pupil's performance. This impact might increase if it would be included in the school curriculum [48,49], with a special impact on science and mathematics subjects. This impact might even go beyond performance and changing environmental behaviours (e.g., [3]) and anti-social behaviour (e.g., [12]).

Regarding the classroom satisfaction, there is only a marginally significant increase between T2 and T3 for the experimental group in Study 1 and not significant at all in Study 2. Although, it would have been expected that the introduction of the green wall and the plants did not increase satisfaction, as evaluated using directed questions about the whole classroom. However, when asked to draw the classroom, the drawings after the introduction of the vegetable pots show the presence of both the green wall and the vegetable pots, as well as other greenery, either already present in the room or imaginary.

Ultimately, these results show that artificial greenery in the classroom has a beneficial role in students´ performance, and in many places where there are no favourable conditions for the introduction of natural greenery, artificial options might be considered. However, the results also show that the engagement with the vegetation as required with the vegetable pots (e.g., daily watering) has far more impact as it makes all the other greenery become noticeable to the pupils, providing a novel vantage point to the understanding of their surroundings, as well as a potential for leveraging pro-environmental behaviours.

5. Conclusions

In consolidated urban areas with little availability of space for outdoor green spaces, indoor greenery might play a pivotal role in pupils' performance and their general well-being. Even though teachers might be interested in introducing indoor greenery, for instance in the form of plant pots, the need for continuous care, namely irrigation over weekends and holidays, tends to jeopardize its success. An alternative with potential impact on pupil's performance is the installation of green walls, which, besides taking up little space, are also automatically irrigated. Living green walls and green roofs can be expensive to install and maintain, although they should be part of best practices when retrofitting schools in old neighbourhoods. Decision support tools may be used to help define the best greening solution for each case scenario [50].

Meanwhile, based on the results of this study, even artificial green walls might have a significant impact on pupils' performance in a short time and at a very low cost. However, further research is important to confirm and explore deeply these results.

For an improved understanding of indoor greenery impacts on students' performance, further research is required, notably on the characteristic of green walls, i.e., artificial versus natural, size and species composition, and mode of interaction. As well, comparative research could be performed between the impact of outdoor and indoor greenery.

As mentioned in the literature, the contact with greenery has benefits to people´s health and well-being [14,42,51]. Further studies should be developed to better understand why people tend to feel better around greenery. Also, when comparing students from lower- with middle-class backgrounds, other variables could be included in the first evaluation moment, such as students' IQ or academic performance, as mentioned by [30].

The attention restoration potential of exposure to natural environments may not only contribute to improving children´s performance in school settings, but could also be applied in other work environments, such as in offices, universities or even at home.

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