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Green walls in schools - the potential well-being benefits

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Green walls in schools - The potential well-being benefits

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Abstract

It is widely acknowledged that mental health disorders in children are increasing and that they are spending more time within the built environment. This paper explores the potential benefits of implementing interior green walls in schools on the anxiety, stress, mood and well-being of children. Analysis of primary data was conducted to broaden the understanding of exterior and interior nature elements currently used in London elementary schools. Secondary data was collected and analysed to explore the impacts of indoor plants, interior green walls and nature views on anxiety, stress, mood and well-being. Additionally, secondary data was analysed to explore the hypothesis that the length of exposure to a nature element impacts positively on well-being. The key findings indicate that nature elements do immediately reduce levels of stress, anxiety and increase well-being and mood. Stress and anxiety levels were most positively influenced in the presence of a window view and indoor plants. While the benefits of the nature element on mood and well-being were noted to reduce after 2-5 weeks of exposure. This research highlights the benefits of introducing nature elements into the built environment in order to increase well-being for elementary school age children, however, further research is required to ensure these benefits are maximised.

Key words: Green walls, indoor plants, nature views, anxiety, stress, mood, well-being

Highlights

- Introducing nature elements into the built environment increases well-being for elementary school age children
- Nature elements have an immediate positive impact on well-being which supports ART and SRT theories.
- Well-being benefits of nature elements reduces somewhere between 2-5 weeks.

1.0 Introduction

In 2004, one in ten children in England aged between 5-15 had met the criteria for a diagnosis of a mental health disorder (either emotional, behavioural, hyperactive or other), which increased to one in nine in 2017 (Zamperoni, 2018). The increase in mental health disorders in children highlights the need for further research to be conducted on child well-being and as children spend more time in school than any other indoor environment outside of the home (Mendell and Heath, 2005) it is imperative that further research is conducted on ways to improve the school environment. Increasing the nature in and around schools may be a way of positively influencing child well-being as a study conducted by Ward et al., (2016) found a child's exposure to greenspace had more of an impact on emotional well-being than physical activity. They found that 'each additional 1% of time spent in greenspace was associated with a 0.66 increase in life satisfaction', suggesting that integrating more greenspace within schools and neighbourhoods may increase child well-being. Furthermore, the integration of greenspaces have been shown to

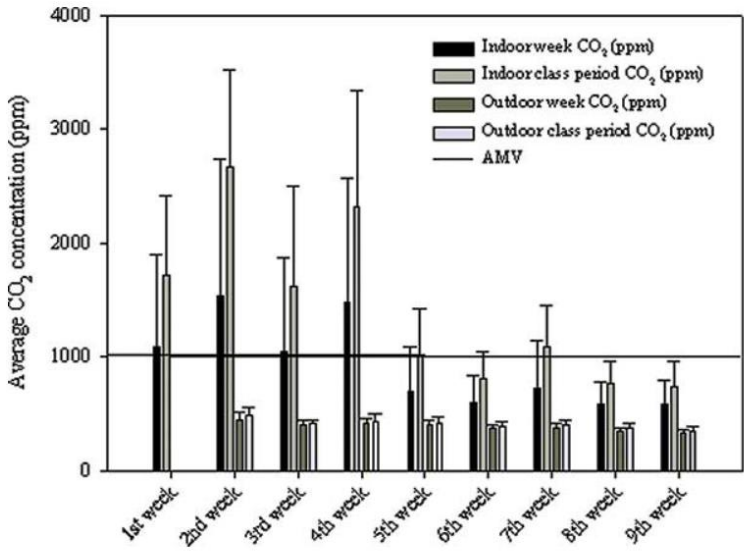

Figure 1. CO_2 measurement findings (Pegas et al., (2012)).

help to reduce air pollution and create a cleaner playground which has in turn been associated with improvements to children's health. A study conducted on the benefits of indoor plants on air pollution in schools conducted by Pegas et al., (2012) found that six potted plants had a significant reduction on classroom air pollution. They calculated the CO_2 levels within a classroom for 3 weeks prior to introducing plants. The benefits on CO_2 levels can be seen in Figure 1. Additionally, previous research has found CO_2 has a negative impact on students' reaction time and performance (Mendell and Heath, 2005) further supporting the view that the integration of nature into the school environment can be beneficial.

1.1 Theories on the benefit of nature

Human beings' subconscious attraction to nature was explored by biologist E.O Wilson (1984) who developed the Biophilia hypothesis which suggests that human beings are instinctively attracted to nature and other forms of life. He defines biophilia as 'the connections that human beings subconsciously seek with the rest of life' (Rogers, 2012). Wilson's Biophilia hypothesis helps explain the potential benefits nature could have on psychological well-being and has encouraged numerous researchers to explore this further. Bratman et al., (2012) noted the variety of impacts that nature has on psychological well-being, and found that nature impacts memory, attention, concentration, impulse inhibition and mood. Kaplan and Kaplan (1989) explored the benefits of nature further and developed Attention Restoration Theory (ART). ART explores the restorative benefits of nature, highlighting nature's ability to capture a person's attention whilst eliciting feelings of pleasure. Kaplan and Kaplan (1989) refer to this concept as soft fascination. Soft fascination is a way of involuntarily distracting a person's attention, providing them with the opportunity to reflect and restore depleted resources. An additional theory exploring the benefits of nature on well-being is Stress Reduction Theory (SRT). Developed by Ulrich et al., (1991) SRT

suggests nature has the ability to reduce stress and that even short exposures to nature have recuperation benefits. They conducted a study in which 120 participants were shown a stressful movie and were then exposed to recordings of six different natural and urban settings. The study found that participants exposed to natural settings reported improved feeling, and that physiological indicators evidenced lower stress levels. They stated that 'during the first four minutes of recovery, all groups experienced at least some degree of recuperation, but the nature groups achieved recovery approaching baseline levels in both autonomic and somatic activity.' Their findings suggest interior green walls may have the ability to help recuperate students stress levels. In addition, nature's ability to aid the recovery of stress was explored by Kaplan (1995), the findings of which further supports the idea of SRT, as they concluded that 'experiences in natural environments can not only help mitigate stress; it can also prevent it through aiding its recovery'.

A study by Shao et al., (2020) examined the potential benefits of horticultural activity for children from both physiological and psychological perspectives. Twenty-six elementary school students with a mean age of 8.12 ± 0.21 years carried out plant-related tasks and a mobile game task for 5 minutes. The participants' heart rate variability, skin conductance, and skin temperature were measured for both tasks using physiological sensors. The emotional responses of the participants were assessed using semantic differential and State–Trait Anxiety Inventory tests straight after each task. Results showed that when compared with the task involving a mobile game, the health status of the participants positively correlated with the horticultural task, including a significant decrease in skin conductance and sympathetic nervous activity, as well as a marginal increase in parasympathetic nervous activity. These results indicate that horticultural activity decreased feelings of stress and increased relaxation. Moreover, the horticultural activity was also associated with a significant increase in comfort, cheerfulness, and a reduction in depression and anxiety.

The installation of green walls into classrooms is a way of bringing nature and the potential well-being benefits into the indoor environment. Kaplan and Kaplan's (1989) concept of 'soft fascination' raises the question of whether green walls 'distract' students involuntarily from complex academic tests/equations and allow them to reflect and revaluate the problem. The importance of green space is further highlighted by Cox et al., (2017) who found that people who live in neighbourhoods with higher levels of vegetation had reduced levels of depression, anxiety and stress. Additionally, spending less time than usual outdoors resulted in worse depression and anxiety. Kaplan and Kapan (1989) concept of soft fascination can help explain how the hypothesis that interior green walls in schools will positively impact on child well-being was achieved. Green walls could have the ability to involuntarily 'distract' students from complex academic work and allow them to reflect on the problem. Alternatively, the soft fascination of the green walls could be the 'distraction' required for students to reflect on personal problems.

Undertaking an in-depth review of the literature to explore the potential well-being benefits of green walls in schools will add to the current literature by providing further insight into the benefits of green walls, indoor plants and nature views on anxiety, mood and stress. A more comprehensive understanding of the potential benefits of nature within an indoor setting will provide the background knowledge for further studies with the aim of improving child well-being.

The aim of this research is to explore the impact of green walls, indoor plants and nature views on anxiety, stress and mood in schools. The research objectives are:

1) To gain an understanding of the current level of external and internal nature elements present in London elementary schools.
2) To examine the impact of indoor plants, interior green walls and nature views on anxiety, stress, mood and well-being.

3) To compare the secondary data and explore whether the length of exposure to indoor plants, interior green walls and nature views has well-being benefits.

The contribution of this work is the assessment of the impact of external and internal nature elements, including indoor plants, interior green walls and nature views in elementary schools. It will also contribute to the understanding of the potential well-being benefits of green walls in schools and will provide further insight into the benefits of green walls, indoor plants and nature views on anxiety, mood and stress. This will provide the background knowledge for further studies with the aim of improving child well-being.

2.0 Background

2.1 Green walls

The current research on green walls within a school setting is limited, however several studies have looked at how green walls can be integrated into the curriculum to enhance education and behaviour (McCullough et al., 2008) and to examine their restorative impacts (van den Berg et al., 2016). The restorative impacts explored by van den Berg et al., (2016) were the social and emotional well-being, stress recovery and cognitive performance of 206 elementary school students. Students completed questionnaires and attentional tests which were repeated two and four months after the green wall was installed. They found that the students in a classroom with a green wall initially scored better on the attentional test than the control group. However, there were no noted differences between the two at two and four month follow ups.

Van den Berg et al., (2016) stated that green walls would have restorative impacts on students and included two main theoretical frameworks for influencing this: Attention Restorative Theory (ART) and Stress Recovery Theory (SRT). They highlighted plants and nature's ability to 'foster restoration from mental fatigue' by acting as a distraction, the plants gaining

involuntary attention thus enabling directed attention to rest and replenish. One of the four qualities that they noted which supports attention restoration is ‘fascination or the capacity of an environment to automatically and effortlessly draw attention.’ Furthermore, they stated in line with Stress Recovery Theory that ‘Plants and other types of vegetation elicit immediate, positive affective responses, accompanied by psychological changes indicative of relaxation.’

Figure 2. Green Walls for a Restorative Classroom Environment: A Controlled Evaluation Study (van den Berg et al., (2016))

Although the findings of van den Berg et al., (2016) do not support the hypothesis of SRT there is still a need to explore the potential well-being benefits of green walls on child well-being due to limitations of the study. Firstly, the findings of the study may have been limited by its short timescale and the limited visibility to participants of the green wall due to its placement on a rear wall within the classroom (Figure 2). Furthermore, the participants social and emotional well-being and stress recovery were assessed via self-administered questionnaires which does not take into consideration any sub-conscious stress recovery that the participants could have been experiencing.

An additional study conducted by Yin et al., (2018) looked at the psychological and cognitive benefits of indoor biophilic features in an office building. The main theoretical frameworks for generating this hypothesis were the biophilia hypothesis proposed by Harvard Biologist E.O Wilson in 1984. Wilson (1984) suggests that human beings have an innate biological connection with nature and, in line with this hypothesis, biophilic design has been promoted to incorporate natural features and systems into indoor environments (Wilson, 1984 as citied by Yin et al., 2018). Yin et al., (2018) looked at the impact of spending time in an indoor environment featuring biophilic design elements on 28 participants. In each visit the participants would experience the environment for five minutes, both in reality and virtually, by using virtual reality. Data was collected via wearable sensors collecting data on blood pressure, galvanic skin response and heart rate in addition to cognitive tests which were administrated after each exposure. Yin et al., (2018) found that the indoor biophilic environment was associated with a decrease in participants blood pressure and skin conductance. In addition to this, participants short term memory improved and a decrease in negative emotions was noted. Yin et al., (2018) concluded that their study indicated that participants virtual experience of an indoor biophilic environment had similar physiological and cognitive responses to experiencing the actual environment in person. Although the study by Yin et al., (2018) was not conducted within a school setting the findings are still relevant and help to broaden our understanding of the positive impacts of indoor nature settings. The findings from this study pose the question of whether similar positive effects would be experienced in students where a green wall is present within the classroom. In addition, it is also hypothesised that the effects of the indoor nature setting may be more prevalent than those noted in the study by Yin et al., (2018) due to the length of exposure.

2.2 Nature Views

Research conducted on the impact of nature views on well-being have looked at the effect of nature views on attention and stress recovery (Li and Sullivan, 2016), the impact of nature views and indoor plants on psychological well-being (Chang and Chen, 2005) and the association between naturalness of window views on well-being and performance (Lindemann-Matthies et al., 2021). Firstly, a study conducted by Li and Sullivan (2016) looked at the impact of window views on student's attention and stress recovery. Similarly, to van den Berg et al., (2016) Li and Sullivan (2016) have based their study on Attention Restoration Theory and Stress Reduction Theory to assess the impact of green landscapes on student performance. They suggest that 'restored attention may be a pathway through which green landscapes impact student performance'. They also suggest that 'reducing the stress that students experience might be a pathway through which green landscapes impact student performance'. In order to test their hypothesises, they randomly assigned 94 students to three classrooms: a classroom with no windows, a room with a window view of a built environment or a room with a window view of nature (Figure 3).

Figure 3. Impact of views to school landscapes on recovery from stress and mental fatigue (Li and Sullivan, (2016)).

Data assessing students stress levels was collected using Electrocardiography (ECG), blood volume pulse (BVP), skin conductance level (SCL) and body temperature. Li and Sullivan (2016) found that attentional capacity was 14.33% higher in participants who were in the classroom with a window view of nature than no window or a view of a built environment. Furthermore, they found that stress reduction was 1.36 units higher in participants who had a view of nature. They concluded that 'green views produce better attentional functioning and a greater recovery from stress'. They also stated that 'there was no evidence that stress mediated the relation between view to green landscapes and attention restoration, suggesting there are two distinct pathways influencing students' psychological and cognitive functioning'. Their findings support the theories behind Attention Restoration Theory and Stress Reduction Theory, however the length of exposure the participants had to the variables could have restricted the impact on participants. It is likely that a forty-minute period is not a true reflection of the amount of time a student would spend in a classroom in a day, month or academic year. Furthermore, the study by van den Berg et al., (2016) found that students only performed better in the attentional test after initial installation of a green wall. This questions the ecological validity and requires further research to truly test the impact of nature views over an extended period of time.

The difference between the impact of nature views and indoor plants on psychological well-being was explored by Chang and Chen (2005) in a study in which 38 students were shown images of offices with a variety of setups: An office with no window, a window with a view of a built environment, a window with a view of nature or an office with indoor plants. Data was collected using a biofeedback device that was connected to each participant. They found that a window view and indoor plants can considerately alter office workers anxiety levels and that a 'window view of nature has a more positive impact on physiological response than indoor plants'. Although this study is based on the impact of nature views and indoor plants

in the workplace the findings are still relevant to the application within schools. Chang and Chen's (2005) study highlights the importance visibility has when exploring the impact of nature on well-being. It also raises the questions of whether nature views would have more of an impact on psychological well-being than green walls. However, the experiments' use of imagery to simulate the office setup and the use of students as opposed to office workers as participants reduces the ecological validity. Furthermore, the study is limited due to the short viewing time participants had of each image, this again does not reflect real life, or the long hours office workers/students spend inside.

A study by Elsadek et al (2019) examined the physiological and psychological relaxation effects of viewing a green façade landscape. Twenty-five Chinese women who were 23 ± 1.5 years of age viewed a building-wall or a green façade landscape for a period of 5 minutes. Data was collected using an electroencephalogram and heart rate variability. Skin conductance physiological measures and psychological measures were carried out using a semantic differential questionnaire and a Profile of Mood State. The findings indicated that the viewing of the green façade compared to the viewing of the building wall, resulted in a considerable increase in alpha relative waves in the frontal and occipital lobes. There was also a noticeable increase in parasympathetic activity, and a decrease in the skin conductance. An increase in relaxation and an improvement in mood state was also noted. Elsadek et al., concluded that viewing a green façade seems to increase human physiological and psychological relaxation compared to viewing a building-wall.

Lastly, a more recent study conducted by Lindemann-Matthiers et al., (2021) has explored whether there is an association between the naturalness of classroom views on well-being and performance in elementary school children. They stated that more natural views will be associated with more positive emotions such as feelings of comfort and friendliness and less negative ones such as anxiety, fatigue and stress. They noted that Attention Restoration

Theory and Stress Reduction Theory as the main theoretical frameworks that shaped their hypothesise however, in contrast to previous studies they ensured participants classroom view remained the same for a more substantial timeframe. The study involved 634 fourth graders from German elementary schools, which meant that the students had been in the same classroom for a year prior to conducting the study. Data was collected via a standardized test and a written questionnaire. Furthermore, Lindemann-Matthiers et al., (2021) found that the weekly amount of time spent in natural places and on plant care was positively associated with children's feelings of comfort and learning satisfaction. In addition, time spent in nature was negatively associated with children's feelings of stress and lack of concentration during lessons. Their study considered numerous different control variables including classroom wall colour and decoration (Figure 4). They noted that the amount of classroom decoration, was negatively correlated with the naturalness of window views and positively correlated with the naturalness of interior classroom views. These correlations highlight the need for

further studies to be conducted to establish whether classroom decorations prevent any of the positive well-being impacts of interior nature/nature views.

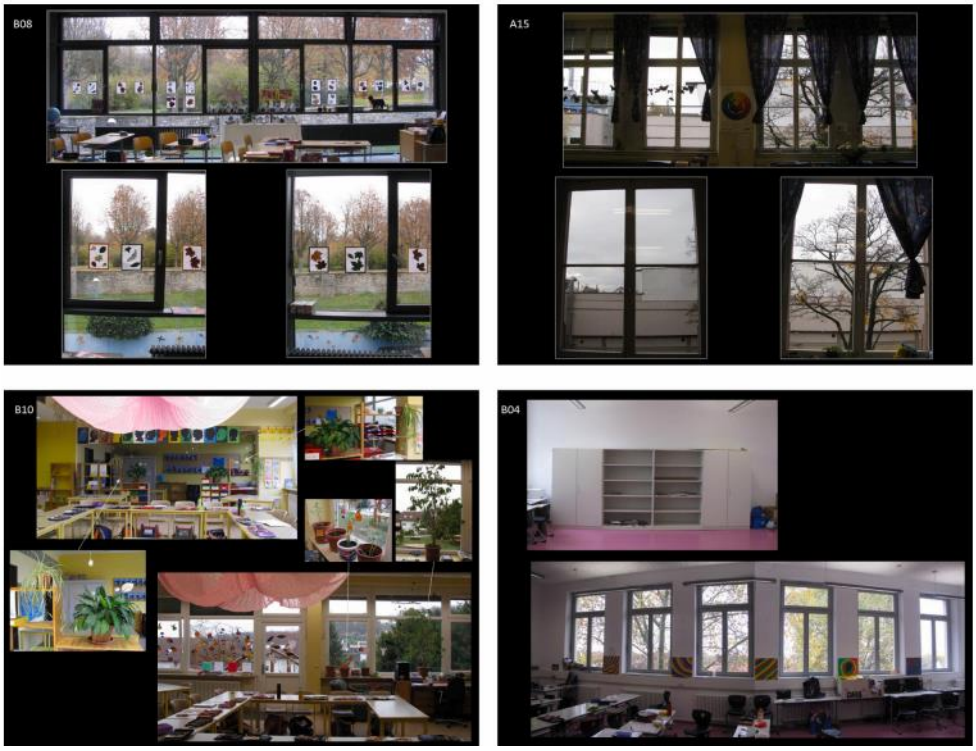

Figure 4. Associations between the naturalness of window and interior classroom views, subjective well-being of primary school children and their performance in an attention and concentration test (Lindemann-Matthiers et al., (2021))

Lindemann-Matthiers et al., (2021) study found that the more natural elements that could be seen from the window the more children felt relaxed and attentive. However, test performance in terms of speed and concentration was not found to be significantly associated with the naturalness of their classroom view. They also found that length of study adds to the reliability of its findings. and explores the idea that classroom decorations could cause a distraction from nature views/interior nature, thus preventing any well-being benefits from being utilised.

2.3 Indoor Plants

A study conducted by Park (2006) on the well-being benefits of indoor plants on surgical patients highlights the positive benefits that plants can have on well-being. This study looked at the impact of indoor plants on patient's length of hospitalization, analgesics used for postoperative pain control, vital signs (such as; blood pressure, temperature, heart rate and respiratory rate), ratings of pain intensity, pain distress, anxiety and fatigue. The study found that patients exposed to plants experienced shorter hospitalizations, more positive physiological responses, less pain, anxiety and fatigue than patients in the control group. Although, the study was conducted on hospital patients recovering from surgery the findings help us understand the physiological and psychological benefits of indoor plants.

The benefits of indoor plants and biophilic design was explored by Hanh et al., (2020) who introduced plants to individual offices and breakout spaces and measured occupants' levels of attention, creativity, productivity and stress. Measurements were obtained via self-administrated questionnaires and showed that introducing plants into individual offices and break-out spaces elicited a statistically significant increase in perceived occupant attention (p=0.018), creativity (p=0.019) and productivity (p=0.023), compared to control conditions. Furthermore, removing plants from individual offices and only placing plants in break-out spaces saw a statistically significant increase in perceived stress levels (p=0.008). The findings from Hanh et al., (2020) extends our understanding of the benefits of indoor plants on attention, creativity and productivity all of which are important performance metrics for the office workers and students. In addition, the study explores the impact of having short exposure to nature elements by placing indoor plants solely in breakout rooms. The office workers increased levels of stress after a short exposure to indoor plants in the break room suggests that short exposure is detrimental to office workers well-being. It is therefore

possible that these results may be seen in school children who do not have nature elements within their classrooms but do have playgrounds surrounded with nature.

Studies conducted on the impact of indoor plants on student's well-being are also limited. However a study conducted by Kim et al., (2013) looked at the impact of indoor plants on classroom air quality (Figure 5). The main conditions they considered were sick building syndrome/sick school syndrome.

Figure 5. Impact of Foliage Plant Interventions in Classrooms on Actual Air Quality and Subjective Health Complaints (Kim et al., (2013)).

Kim et al., (2013) found that volatile organic compounds showed high concentration in the classrooms without indoor plants but demonstrated low concentration in the classrooms with indoor plants. However, the self-administered questionnaires completed by participants did not find a significant decrease in sick building syndrome/sick school syndrome. These measures were taken after three months of the plants being located within the classrooms. Although Kim et al's., (2013) study did not find a decrease in sick building syndrome/sick school syndrome, but it did find a reduction in volatile organic compounds which has been noted to potentially impact productivity levels (Wolkoff, 1995). This study also highlights the air quality benefits of indoor plants however, the study is limited due to the studies short time span. It may be possible that the benefits of the indoor plants may have been increased, had

the plants been present for the whole academic year, and if so – participants may have noted a reduction in sick building syndrome/sick school syndrome.

A further study conducted within a school setting was carried out by Han (2008) who looked at the effect of limitedly visible plants on student's behaviour, psychological and physiological well-being. The study was a quasi-experiment conducted within a school with 76 students over a semester (June to January). Data was collected via self-administrated questionnaires of which ten were completed by each participant, examination scores, sick leave and punishment records. Han (2008) found via the questionnaires completed by participants that plants had an immediate positive effect on comfort and friendliness. It was also noted that participants within the experimental group had fewer sick leave hours and lower punishment records than the control group, suggesting that indoor plants had a positive effect on student's health and behaviour. Overall, Han (2008) was not able to find a positive effect of the indoor plants for the study as a whole. The studies inability to support its hypotheses could be due to the selection of participants as the study was conducted with 76 students split between the experimental and control group. The students were not evenly split with the control group having a total of 41 students, only eighteen of the participants being female. Interestingly a study conducted solely on female students found that indoor plants increased the happiness of high school students (Najafi and Keshmiri, 2018), which poses the questions - do indoor plants effect females and males differently? The findings of Han's (2008) study may have been more supportive of the hypothesis had the gender of the participants been more evenly spilt. Overall, the findings from Han's (2008) study supports the idea that the effect of plants and nature can be limited due to limited visibility. The contradiction between the findings of Najafi and Keshmiri (2018) and Han (2008) further highlights the need for further research on the well-being impact of indoor plants and green

walls in schools. In addition, further research is also needed to confirm whether gender does play a role on the effect of indoor plants.

2.4 Research Objectives

It has been highlighted that the existing research conducted on green walls within a school setting is limited and similarly, studies conducted on the benefits of indoor plants on child well-being are sparse and the findings are contradictory and inconclusive. Undertaking a meta-analysis of the literature surrounding the well-being benefits of indoor plants, green walls and nature views will help further the knowledge on the potential benefits of interior green walls in schools. By focusing specifically on nature benefits on stress, mood and anxiety this research will aim to fill a gap within the current literature. The objectives for this research are: 1) Gain an understanding of the current level of external and internal nature elements present in London Elementary Schools; 2) Collect data/information on the impact of indoor nature elements (specifically interior green walls, indoor plants and nature views) on the mental health (stress, mood anxiety and well-being) of the occupants of schools and offices; 3) Analyse data to assess whether the indoor nature elements have any impact on the mental health of school children and office workers; 4) Compare the secondary data and explore whether the length of exposure to indoor plants, interior green walls and nature views affects any well-being benefits.

3. Methodology

Exploring the potential well-being benefits of green walls in schools will enhance our understanding of the impact of indoor nature on mental health. Previous studies conducted on the benefits of exterior greenspace along with theories such as ART and SRT suggest that interior green walls could have a positive impact on child well-being.

Carrying out a meta-analysis of studies will hopefully add to the research and our understanding of the potential well-being benefits of green walls. The term meta-analysis was coined by Gene Glass and defined as 'the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings' (Glass, 1976 as cited by Cheung, 2015). A benefit of carrying out a meta-analysis was noted by Stanley (2001) 'if a number of individual studies have been conducted on a particular subject, using different data sets and methods, then combining their results can furnish more insight and greater explanatory power than the mere listing of the individual results.' By looking at the findings of previous studies conducted on the well-being benefits of interior green walls, indoor plants and nature views within office and school settings, this study will help aid our understanding of whether an interior green wall could have well-being benefits for students. Secondary data collected was a mix of quantitative and qualitative, although ideal studies will have collected data using similar quantitative forms of measurements such as State Anxiety Inventory (STAI), Electroencephalography (EEG) and the 7 item Warwick-Edinburgh Mental Well-being scale. Meta-analysing studies conducted on the benefits of interior green walls, indoor plants and nature views prevents one or two studies with positive/negative findings from influencing the studies overall results. Instead, all relevant studies collected were analysed to see whether there are any potential well-being benefits of green walls in schools.

3.1 Data collection

In order to obtain relevant studies keywords such as: indoor plants, green walls, nature views, depression, low mood, anxiety, well-being and stress were used for searches. Ideal studies are either true or quasi-experiments, quasi-experiments being experiments that involve manipulation of a social setting, but as part of a naturally occurring attempt to alter social arrangements (Bryman and Bell, 2015). Meta-analysing quasi-experiments, preferably with a

control group helps to improve the ecological validity due to the lack of artificial intervention. True experiments should also have high levels of reliability due to the experimenter's control over the elements such as participant sampling, ensuring better control over the split of participants between the control and experiment group as well as guaranteeing an even gender split. In addition, to ensure the practicality of studies a review of each was conducted looking at the purpose of the study, when it was carried out and how the data was obtained. Reviewing the purpose of the study ensured that the study was conducted with the relevant target population, testing the impact of a suitable nature element on either mood, anxiety, stress or well-being.

In addition to the secondary data collected and analysed, a small number of questions were asked to elementary school teachers. The five questions sent to four elementary school teachers to gain an insight into the level of exterior and interior nature elements were:

1) Does your school have exterior greenery that students can access daily?

   1a) If so, please provide a small description of these areas.
2) In your opinion what percentage of the school grounds is greenery and what is concrete?
3) Do the classrooms within the school have any interior nature (indoor plants, green walls)?
4) Does your classroom have a view of nature?
5) In your opinion do you think students would benefit from more external and internal nature elements?

Although the teachers' responses are not an accurate representation of the level of greenery in and around schools within the United Kingdom, they increase our understanding of the level of nature currently present within schools. Four of the questions asked were closed-ended questions with one asking for a brief description of the nature elements on school grounds.

Closed-ended questions were chosen to ensure the responses were easy to process and enabled better comparisons to be drawn.

3.2 Data Analysis

In order to better store the data collected the studies were coded using the nature element e.g. Green walls, indoor plants and nature views. The main summary measures that were noted upon review of studies were: The nature elements (green wall, indoor plant and nature view) impact on stress, mood, anxiety and well-being and period of exposure to the nature element. Coding the studies allowed for easier analysis of the studies and more visibility of any correlations. Analysis of the data collected was conducted using a framework method looking at the similarities and differences between studies. Jensen and Allen (1996) state that this process includes two aspects, one (hermeneutic) is doing justice to the original primary findings and the other (dialectic) is comparing and contrasting them with each other (Jensen and Allen, 1996 cited by Timulak, 2009). The data collected was separated and analysed into quantitative data and qualitative data. This allowed for easier analysis of the data and for similar measurements of data to be grouped together. Evaluating how the data was obtained enabled studies with reliable findings to stand out.

Carrying out a meta-analysis of both the quantitative and qualitative data allowed a narrative synthesis to be generated. Bryman (2008: 102) defines narrative synthesis as ‘a narrative to bring together the key findings relating to the research question, often accompanied by simple statistical summaries such as the percentage of studies that examined a certain issue or that adopted a particular perspective.’ Analysis of the responses received from teachers was completed by coding the answers. The relatively small quantity of responses made comparison easier and allowed any commonalities to stand out.

3.3 Data comparison of short and long-term impact

Data collected was grouped together based on length of the study and a further group for any long studies that noted the nature elements' immediate impact on mental health. Grouping the data into length of study and looking at whether a positive or negative outcome was noted helped compare the short and long-term impacts of nature elements. Knowing the potential short and long-term impacts of a nature elements will provide further knowledge on the immediate benefits of nature elements as highlighted by van den Berg (2016) and Han (2008). Furthermore, the findings will enhance our understanding of the potential long-term benefits of interior green walls in schools and could possibly highlight a period when nature elements are shown to have a more significant impact on mental health.

4.0 Findings

This dissertation is concerned with the potential benefits of indoor plants, interior green walls and nature views on anxiety, stress, well-being and mood. Seven studies in total were analysed in depth to assess what impact nature elements have on anxiety, stress, well-being and mood. The seven studies were coded based on the nature element they explored, for example: The letter 'I' refers to indoor plants, 'N' refers to nature view and 'G' refers to green walls. The coding for the studies is shown in Table 1.

Table 1. Coding for studies based on the nature element explored.

Code	Study Title	Author	Year
I25	Influence of Limitedly Visible Leafy Indoor Plants on the Psychology, Behavior, and Health of Students at a Junior High School in Taiwan	Han	2008
N7	Human Response to Window Views and Indoor Plants in the Workplace.	Chang and Chen	2005
I31	Effects of viewing flowering plants on employees' wellbeing in an office-like environment.	Elsadek and Liu	2020
I4	Do indoor plants improve performance and well-being in offices? Divergent results from laboratory and field studies	Thatcher et al	2020
I20/G2	Greening the classroom: Three field experiments on the effects of indoor nature on students' attention, well-being, and perceived environmental quality	Van den Bogerd et al	2020
I9	The Relationship Between Classroom Indoor Plants and Happiness of Female High School Students	Najafi and Keshmiri	2018
I18	Effects of an indoor plant on creative task performance and mood	Shibata and Suzuki	2004

4.1 Anxiety

The studies that looked at the impact of nature elements on anxiety were grouped together. Of these, two studies used the State Anxiety Inventory (STAI) to measure participants levels of anxiety. These were: I25 and N7 (Table 1). The STAI consists of two 20-item scales for measuring the intensity of anxiety as an emotional state. Participants report the intensity of their feelings of anxiety ‘right now at this moment’ by rating themselves on the following 4-point scale: 1) Not at all, 2) Somewhat, 3) Moderately so, 4) Very much so (Spielberger, 2010).

The first study, I25 conducted by Han (2008) looked at the impact of limitedly visible indoor plants on student’s anxiety levels. The students average age was 13.5 years old, and the study was conducted over a semester. The second study, N7 was conducted in Taiwan by Chang and Chen, (2005) and looked at the impact of nature views and indoor plants based in a virtual office setting.

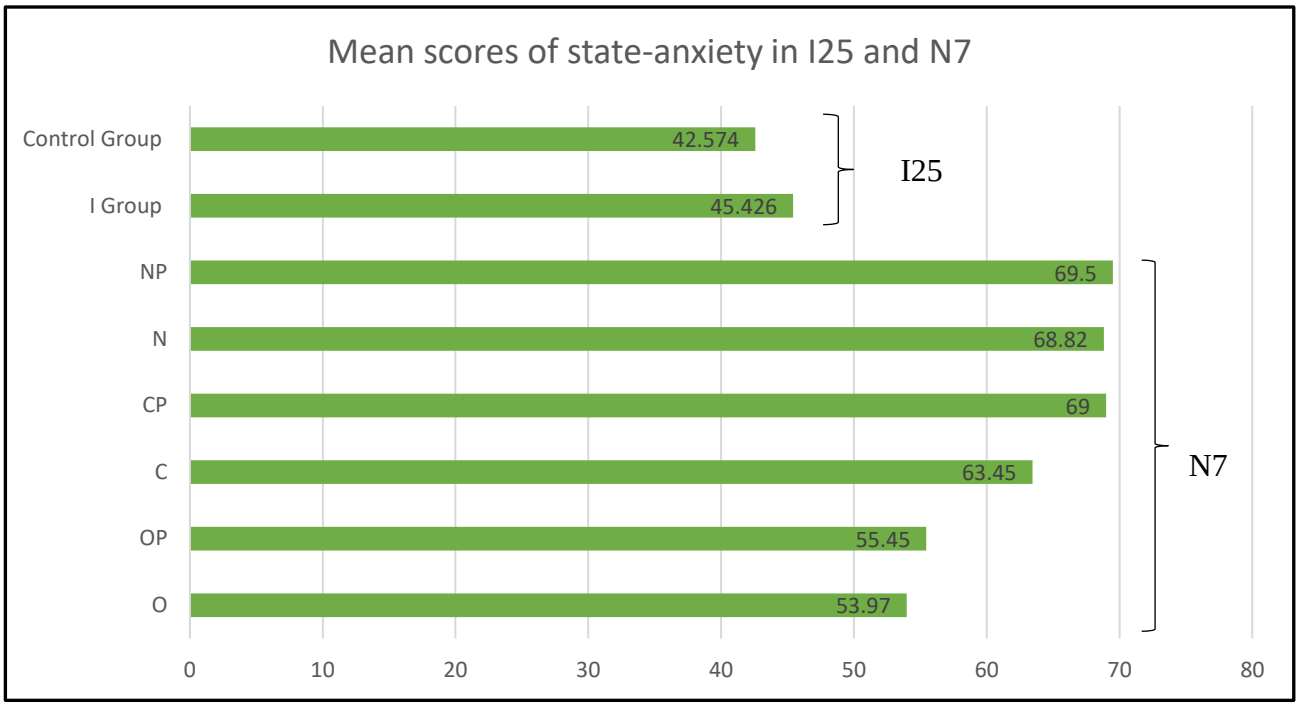

Figure 6. The mean scores of participants STAI responses when in the presence of different nature elements. Individual STAI scores range from 20 to 80 and thus the higher the value, the lower the state-anxiety level. Note: N7 study code: O = without a window view, OP = Without a window view + indoor plants, C = Window with a view of a city, CP = Window with a view of a city + Indoor plants, N = Window with a view of nature, NP = Window with a view of nature + indoor plants.

The three lowest levels of state-anxiety were all noted within study N7 in the presence of the following nature elements: NP = Window with a view of nature plus indoor plants (mean score of 69.5), CP = window with a view of a city plus indoor plants (mean score of 69) and N = Window with a view of nature (mean score of 68.82) (Figure 6)(Table 1). In addition, these three elements noted the largest difference in state-anxiety mean scores when compared to the control group. Han (2008) (Study I25) experimental group noted a difference of just 2.852 when compared to its control group, whereas the largest difference noted in Chang and Chen (2005) (study N7) was 15.53, noted between NP (window with a view of nature plus indoor plants) and O (without a window view). In addition, OP (without a window view plus indoor plants) had the closest difference of 1.48 to that noted in Han (2008) (Study I25). This suggests that a window view decreases state-anxiety levels more than indoor plants.

Furthermore, the difference of 9.48 noted between C (window with a view of a city) and O (without a window view) suggests that a cityscape window view decreases anxiety more than indoor plants.

4.2 Stress

The studies that looked at a nature elements impact on stress were: N7 and I31 (Table 1). Both of those two studies used Electroencephalography (EEG) to measure brain activity. Reisman (1997) defines electroencephalogram (EEG) as the integrated voltage observed on the surface of the scalp due to the activity of neurons in the brain. From the EEG spectrum, activity can be observed in the 8-12 Hz. (alpha) frequency band, where increased activity is related to increased relaxation (decreased stress) (Reisman, 1997).

The first study, I31 conducted by Elsadek and Liu (2020) looked at the impact of different coloured flowering plants on employees well-being in an office environment. The study was conducted on 30 female office workers with an average age of 29. The EEG measurements within study I31 were collected from the pre-frontal lobe (AF3, AF4). These measurements allowed the capturing of alpha relative wave power, these channels were selected because the pre-frontal lobe regulates cognition and thinking, while the occipital lobe presents the visual information processing (Elsadek and Liu, 2020). The second study, N7 was conducted by Chang and Chen (2005) and looked at the impact of nature views and indoor plants on office workers. The EEG measurements in study N7 were also collected from the pre-frontal cortex two measurements were collected, EEG-a and EEG-b. EEG-a measures the alpha wave activity of the left side of the brain, while EEG-b records the right side of the brain.

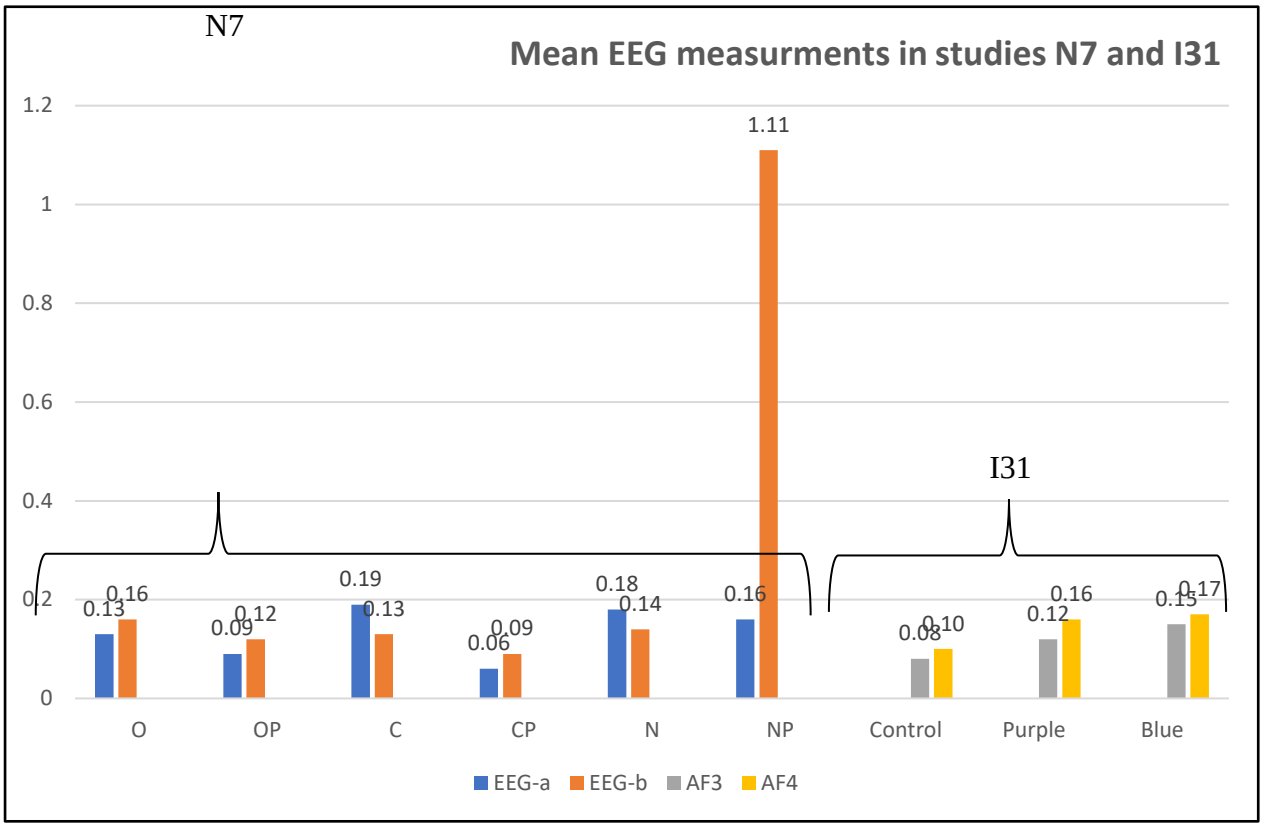

Figure 7. The mean scores of participants EEG results when in the presence of different nature elements. Increased activity is related to increased relaxation (Reisman, 1997). Note: N7 study code: O = without a window view, OP = Without a window view + indoor plants, C = Window with a view of a city, CP = Window with a view of a city + Indoor plants, N = Window with a view of nature, NP = Window with a view of nature + indoor plants.

The three highest levels of EEG activity and thus the most relaxed mean state of participants were all noted in study N7 (Figure 7) (Table 1). Participants were noted to be most relaxed when surrounded by nature element NP (window with a view of nature plus indoor plants) with an EEG-b reading of 1.11µV. However, it should be noted that this rating of 1.11 µV is 0.92 µV higher than the next highest rating of 0.19 µV in the presence of nature element C (Window with a view of a city). Further research is required to ensure the high rating of 1.11 µV is not an anomaly. The third highest level of EEG activity measured was collected in the present of nature element N (window with a view of nature). In addition, further research is required to reconfirm the measures obtained in Chang and Chen (2005) (Study N7). In total, 6 of the measures obtained in the experimental groups (OP EEG-a and EEG-b, C EEG-b, CP

EEG-a and EEG-b and lastly N EEG-b) were lower than the two measures of 0.13 µV (EEG-a) and 0.16 µV (EEG-b) obtained during the control group. In total only 4 measures (C EEG-a, N EEG-a and NP EEG-a and EEG-b) are above those obtained in the control group, whereas the measures from Elsadek and Liu (2020) study are all above those obtained during the control group.

Elsadek and Liu's (2020) study compared the impact of purple and blue flowers on stress levels. The findings of both AF3 and AF4 readings suggest that blue flowers reduce stress levels slightly more than purple flowers.

4.3 Well-being

There were two studies that looked at the impact of nature elements on well-being, these were: I4 and I20/G2 (Table 1). The first study looked at I4 was conducted by Thatcher et al., (2020). This study looked at the impact of indoor plants on employee's well-being. Three studies were conducted in total but only two have been included in these findings. The two studies analysed looked at the impact of indoor plants on well-being after 12 weeks and 17 weeks. Two different scales were used to assess well-being. Study 2 measured well-being using the 7 item Warwick-Edinburgh Mental Well-being scale (SWEMWBS) whereas, study 3 measured well-being using the Kessler Psychological Distress scale which consists of 6

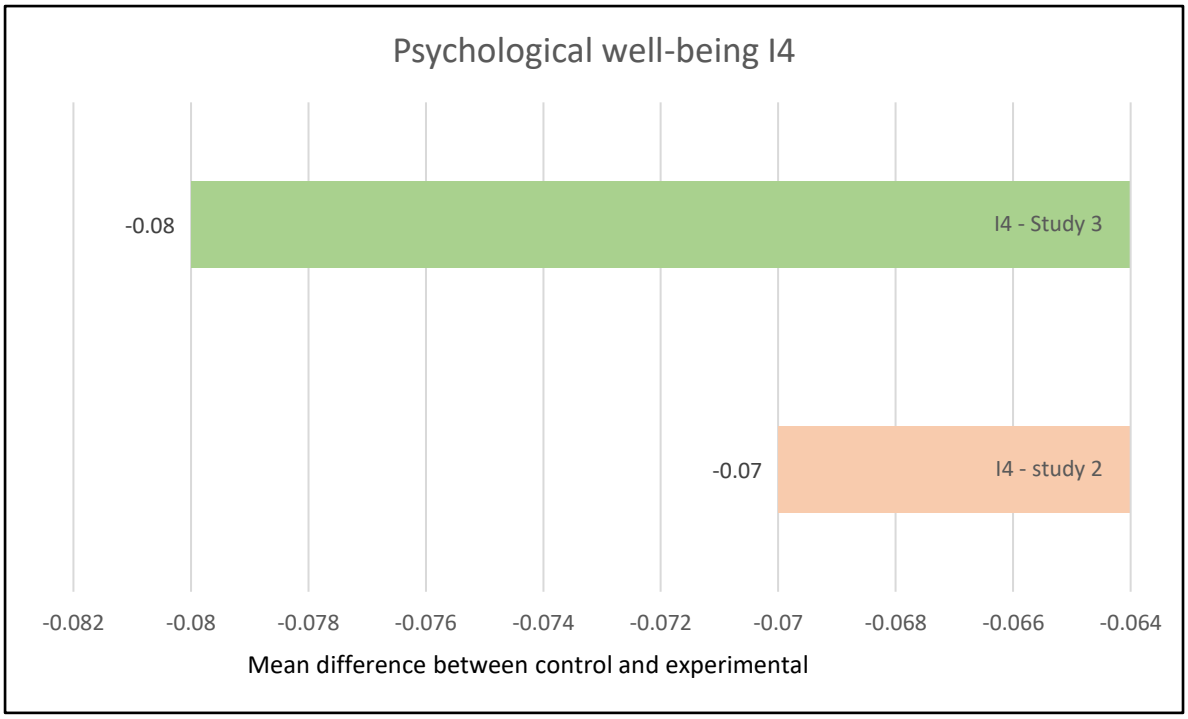

Figure 8. The difference between the control group mean and experimental group mean for both studies.

items assessing non-specific psychological distress. Although different scales were used to assess well-being both scales used a 5-point frequency scale, which allowed comparison to be carried out on the control group and experimental groups mean (Figure 8). Interestingly, both study 2 and study 3's experimental groups' means were lower than the mean noted in the control group and thus suggests that indoor plants do not have an impact on employee well-being.

The second study looked at I20/G2 was conducted by van den Bogerd et al., (2020). Again this study was separated into three separate studies, only two of which were analysed. Study 1 looked at the well-being impacts, specifically stress, fatigue and vigour of indoor plants on university students. Study 2 looked at the well-being impacts, specifically stress and fatigue of indoor plants and flowers on secondary school children. Both study 1 and study 2 assessed well-being using the Dutch Profile Mood States (POMS). Student were asked how they felt at

the time of completing the questionnaire, responses were provided on a 5-point scale ranging from 0 (not at all) to 4 (very much). A comparison of the control groups and experimental groups mean scores were analysed (Figure 4:4).

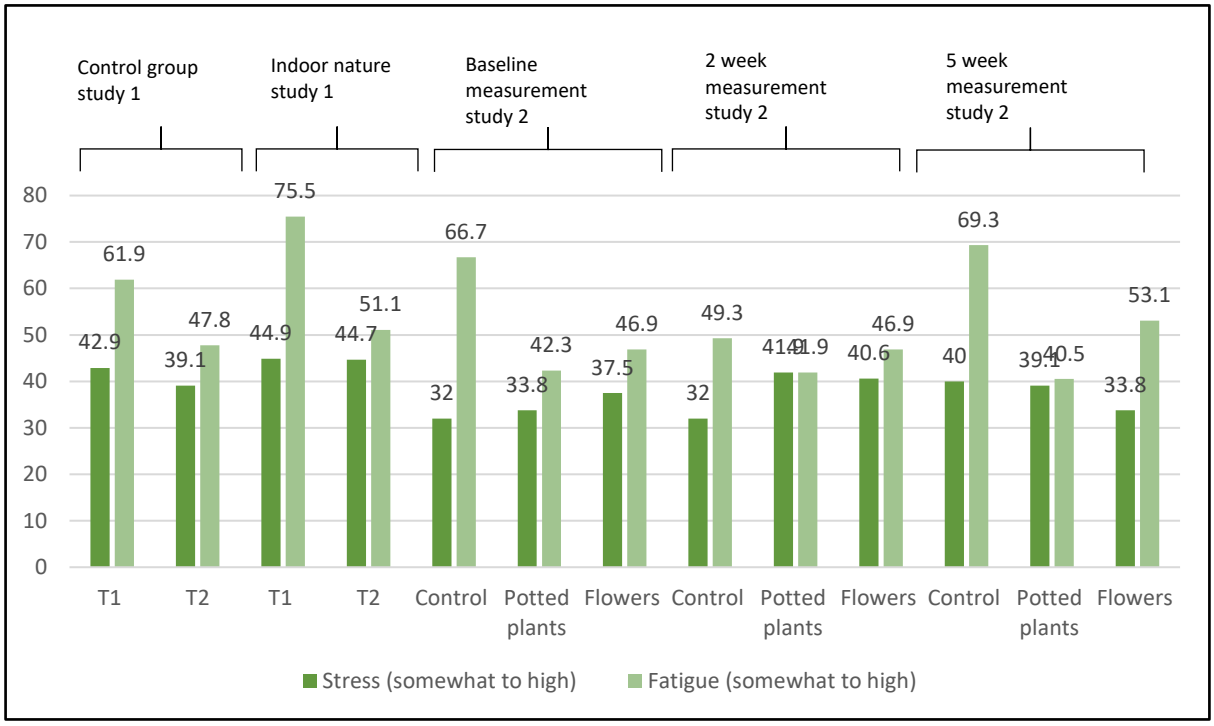

Figure 9. The mean findings of Study 1 and Study 2 of I20/G2. Two measurements were obtained for both the control group and indoor nature for Study 1. Measurements for Study 2 were carried out at the baseline, 2 weeks and 5 weeks, each time measurements were taken for a control group, a potted plant group and a flowers group.

The highest mean measurement recorded was 75.5, this was recorded during study1 for fatigue, in the presence of indoor plants. The two next highest measurements were 69.3 and 66.7, which were both recorded for fatigue in study 2. Both measurements are from control groups during baseline and 5 weeks. As the control groups of study 2 generated higher mean scores than those noted in the experimental groups, it suggests that potted plants and flowers do not impact fatigue. However, the control measurements obtained for stress are lower than potted plants and flowers at baseline and 2 weeks, suggesting that the nature elements do have an initial impact on stress. However, the control group measurement for stress were higher than the potted plants and flowers at the 5-week mark. Further studies will need to be

conducted to confirm whether the impact of potted plants and flowers on stress decreases over time.

4.4 Mood

Three studies looked at the impact of nature elements on mood and were analysed. These were: I20/G2, I9 and I18 (Table 1). The first study I20/G2 was conducted by van den Bogerd et al., (2020) and looked at the impact of green walls and potted plants on secondary vocational students. Mood was assessed on four emotions (joy, happiness, fatigue, relaxed). These four emotions were assessed on a five-point Likert scale ranging from not at all applicable to very applicable. Measures were taken at the baselines, 2 weeks and 5 weeks after installation of the nature element.

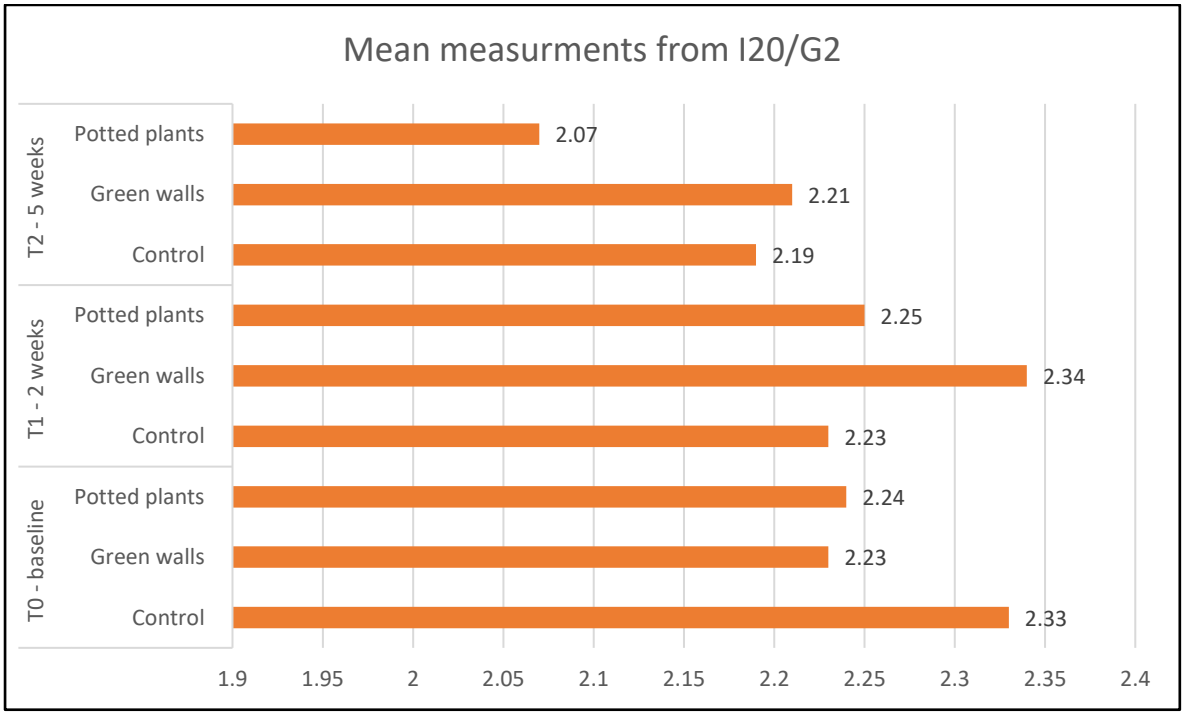

Figure 10. The mean measurements obtained during study 3 of I20/G2.

The highest mean measurement of 2.34 was recorded 2 weeks after installation of a green wall (Figure 10). The second highest mood measurement recorded was 2.33 which was obtained during the baseline in the control group. The control groups measurements at the 2

week and 5-week point were lower than those of the green wall, however, potted plants in the 5-week stage received the lowest measurement of the study of 2.07. In addition, mean measurements from 2 weeks were higher than those obtained at 5 weeks. This could suggest that the nature element has an initial impact on mood, but this depletes as time goes on.

The second study I9 was conducted by Najafi and Kehmiri (2018) and looked at the impact of indoor plants on mood. The study was conducted solely on female high school students. Participants were given questionnaires which included 29 items, each of which included four choices. The first choice was scored as zero and the fourth choice was scored as three.

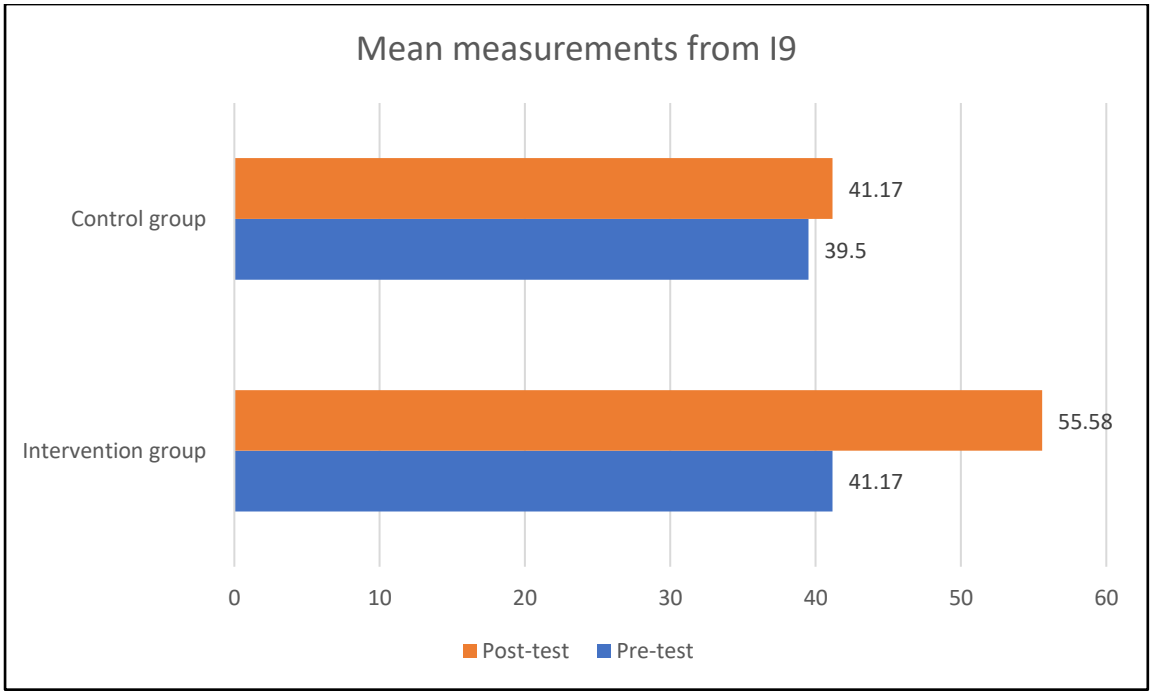

Figure 11. The mean measurements of study I9

The mean measurements of I9 show an increase in both the pre-test and post-test measurements for the intervention group when compared with the control group (Figure 11). This suggests that indoor plants do have a positive impact on female students' mood. It shows that the impact of the indoor plants is stronger post-test with an increase of 14.41 from the pre-test measurement.

The last study I18, was conducted by Shibata and Suzuki (2004) and looked at the impact of indoor plants on the mood of undergraduate students. To assess the mood levels of the participants questionnaires with a seven-point scale: 1 (strongly disagree) to 7 (strongly agree) were completed. Nine terms in total were used in the study to determine mood however only four were analysed: Happy, tired, tense and calm.

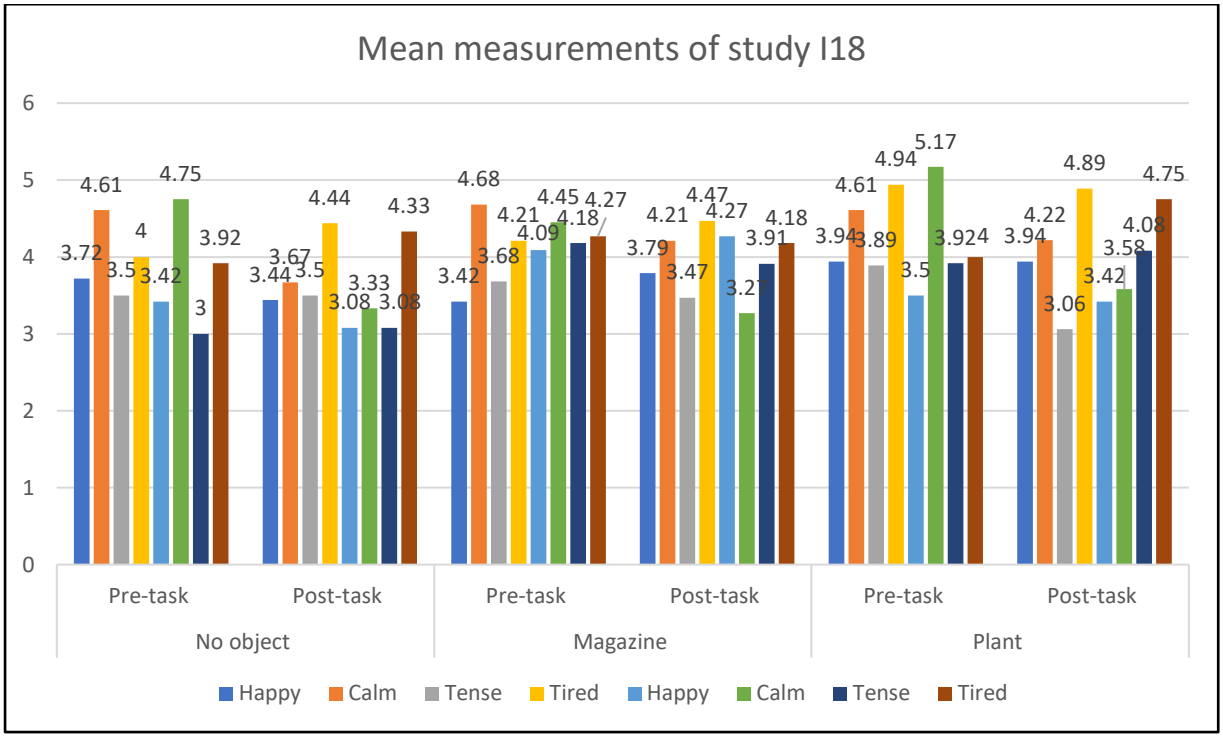

Figure 12. The mean measurements obtained in study I18

The highest mean measures recorded in study I18 was 5.17 for the mood status calm, which was recorded in the pre-task stage in the presence of indoor plants (Figure 12). Other measurements of calm recorded in pre-task stages were 4.75 in the no object group, and 4.45 in the magazine group. This suggests that indoor plants could impact levels of calmness, however it should be noted that the mean measurement for calm dropped to 3.58 in the post-task plant measurement. This suggests that the impact of indoor plants on levels of calmness are only apparent before completing the task. The highest happiness levels were noted as: 3.79 (in the post-task magazine group) and 3.94 (in the pre-task and post-task plant group).

4.5 Statistical significance of studies

The *P* value of the nine studies looked at were compared to see which studies found a significant difference between the control group and intervention group. Figure 13 shows the *p* value for seven of the studies. Study I20/G2 was not included in this analysis as it did not confirm the *p* value for any measurements obtained. The studies which noted the most significant difference were: study N7 ($p = 0.001$) which looked at the effect of nature views and indoor plants on state-anxiety, and 131 which looked at the impact of indoor plants on mood ($p = <0.01$) and stress ($p = <0.01$). Study I25 noted the least significant difference between the control group and intervention with a *p* value of 0.761.

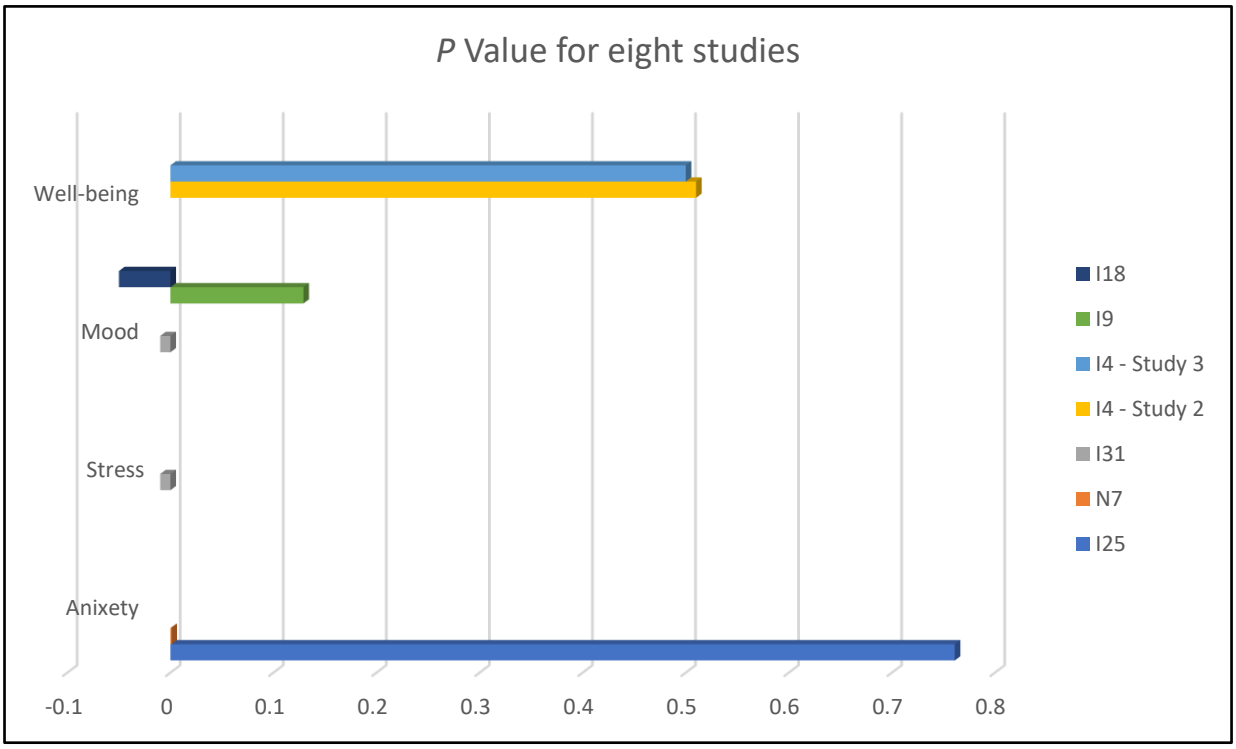

Figure 13. Shows the p value for seven of the studies analysed.

4.6 Short term Vs Long term impacts of nature elements

4.6.1 Anxiety

The two studies that looked at the impact of nature elements on anxiety were N7 and I25 (Table 1). Study N7 was not a true or quasi-experiment and therefore the results only

consider the immediate impact of nature elements (Figure 6). N7 found participants had the lowest level of anxiety (with a mean score of 69.5) in the presence of a window view of nature and indoor plants. In contrast study I25 was carried out over a semester and noted a very slight decrease in anxiety levels in the intervention group. This suggests nature elements do positively influence anxiety levels, the effect of which could be felt more strongly at initial exposure. However, more research is required to confirm initial and long-term impact of nature elements on anxiety.

4.6.2 Stress

The two studies analysed that looked at nature elements impacts on stress were I31 and N7, both of which looked at the immediate impact (Table 1). The results of I31 are show in Figure 7 and found that participants were more relaxed in the presence of flowers, but these findings were not significant. In addition, study N7 found participants were more relaxed in the presence of nature views and indoor plants. The findings of both studies show a positive impact of nature elements. This suggests that nature views and indoor plants can have a positive immediate impact on stress. However, as data was collected via EEG the results only showed the initial impact of nature view and indoor plants on stress. Further research is required to measure the impact of stress levels after longer exposure to nature elements.

4.6.3 Well-being

The two studies that looked at well-being both included two studies each. I4 looked at the impact of indoor plants after 12 weeks (study 2) and 17 weeks (study 3) whereas, I20/G2 looked at the immediate impact (study 1) and the impact after 5 weeks (study 2) (Table 1). The findings of study I4 are shown in Figure 8. The means scores were lower in the intervention group than the control group for both study 2 and study 3. This suggests that

there was no impact of the indoor plants on well-being after 12 and 17 weeks. In contrast, study 120/G2 (Figure 9) did note an immediate impact on fatigue levels when in the presence of indoor plants. However, well-being levels for study 2 tested at 5 weeks were lower than those noted in the control group. These combined findings suggest that indoor plants only have an immediate impact on well-being.

4.6.4 Mood

Three studies were analysed to test the impact of nature elements on mood. These were I20/G2 (study 3), I9 and I18 (Table 1). The findings from I20/G2 are shown in Figure 4:5. The highest mean measurement of 2.34 was recorded 2 weeks after installation of the green wall. The mean measurements recorded were higher at 2 weeks after installation than those obtained at 5 weeks. However, the findings of I9 (Figure 11) show the impact of indoor plants being stronger at 12 weeks than at installation. The last study looked at, I18 (Figure 12) found that indoor plants do impact levels of calmness, however these levels reduced on the post-task measurement. This could suggest that indoor plants have an immediate impact on levels of calmness or that the impact of the indoor plants is less apparent once participants are distracted by a task.

4.7 Teachers' responses

To gain an understanding on the level of external and internal nature currently present in London elementary schools a short questionnaire was sent to four elementary school teachers. The teachers were from a combination of public and private schools located in different parts of London.

4.7.1 Exterior greenery

The first question teachers were asked was: 'Does you school have exterior greenery that students can access daily? If so, please provide a small description of these areas'. All four of the teachers answered yes to this question and the most popular nature element noted were bedded plants surrounding either the school grounds or the playground and

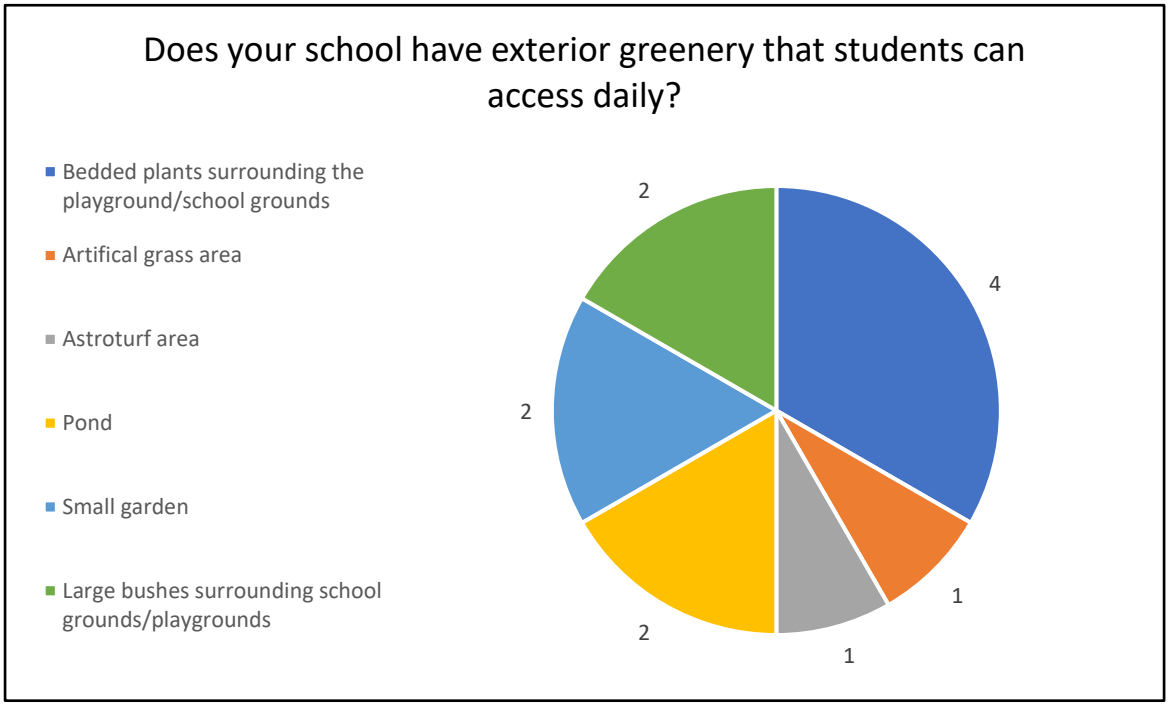

Figure 14. The description of greenery and quantity of teachers who noted each element.

areas with artificial grass (Figure 14). Two of the teachers noted that the school grounds include a pond but note that this is not constantly accessible to the students.

The second question that the teachers were asked was 'what percentage of the school grounds is greenery and what is concrete?' The results of which are shown below in Figure 15.

Two of the teachers provided percentages for artificial greenery versus concrete which is shown in Figure 16. The findings show that two of the schools try to balance out the concrete by implementing artificial greenery onto the school grounds. Both of the graphs highlight the lack of natural greenery currently present on schools' grounds.

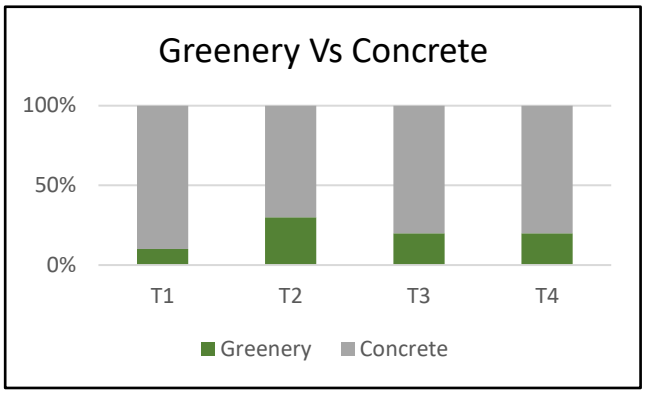

Figure 15. The percentage of greenery Vs concrete from each teachers' perspective.

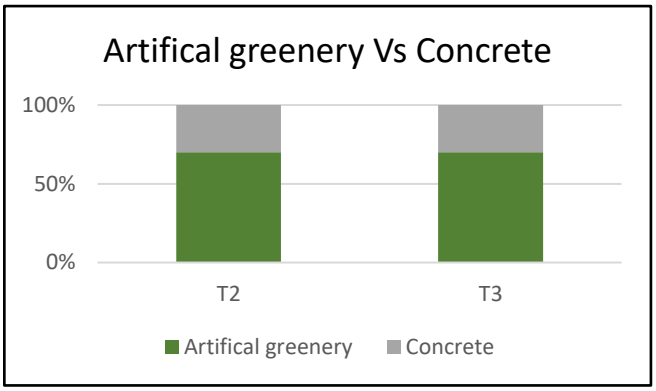

Figure 16. The percentage of artificial greenery Vs concrete from the two teachers' perspectives

4.7.2 Interior greenery

The third question asked to the teachers was 'do the classrooms within the school have any interior nature (indoor plants, green walls)?' The responses received from the teachers varied. Two teachers stated no/the odd classroom has a plant, one teacher stated the school has three green walls in three classrooms. From the responses there was one teacher who noted that sometimes seeds are planted, and the students look after these until they have grown and can be added to the garden.

The fourth question asked whether the classrooms have a view of nature. Again, the responses received varied. Two teachers noted a nature view from a distance, however one teacher noted the view was only visible in two new classrooms. The two other teachers stated that large palm plants could be seen out of the window and that the playground/field was visible from the classrooms.

4.7.3 Teachers opinion on amount of greenery

Lastly the teachers were asked 'in your opinion do you think students would benefit from more external and internal nature elements?' The response to this question was a unanimous

yes with two teachers suggesting that this could be incorporated into the science curriculum and would benefit student's knowledge and understanding of climate change and sustainability.

The teacher's responses, although limited, helps to build our understanding of the nature elements currently present in London elementary schools. It shows how some schools have tried to balance out the concrete/greenery balance by incorporating artificial greenery. The teacher's responses also highlight that some schools lack nature views other than those far away in the distance. In addition, three out of four teachers noted either no or limited indoor plants (only when seeds are planted and looked after by the students) currently in their classrooms. One teacher stated that three classrooms have green walls within their classrooms, which shows that it is possible to introduce green walls into classrooms.

5.0 Discussion

This study analysed the impact of indoor plants, green walls and nature views on anxiety, stress, well-being and mood. It was hypothesized that indoor plants, green walls and nature views would all have a positive impact on anxiety, stress, well-being and mood. This hypothesis was generated using the theoretical frameworks of Attention Restorative Theory (ART), Stress Recovery Theory (SRT) and Biophilia Hypothesis. Attention Restoration Theory and Stress Recovery Theory highlight plants and nature's ability to 'foster restoration from mental fatigue' by acting as a distraction. The plants gain involuntary attention enabling directed attention to rest and replenish (van den Berg et al., 2016). Whereas Biophilia hypothesis proposed by Harvard Biologist E.O Wilson (1984) suggests that human beings have an innate biological connection with nature, in line with the hypothesis biophilic design has been promoted to incorporate natural features and systems into indoor environments (Wilson, 1984 as citied by Yin et al., 2018). It was hoped that by reviewing secondary data

that a more substantial correlation in findings in line with ART, SRT and Biophilia hypothesis would become obvious. However, large contradictions in the findings are still apparent.

The primary data collected from teachers provided an understanding on the level of external and internal nature currently present in London elementary schools. One interesting finding was the percentage of artificial greenery versus concrete present on the school grounds. Two of the schools noted a high level of artificial greenery with Teacher 2 stating that their school grounds have 70% artificial versus 30% concrete (30% real greenery versus 70% concrete). Teacher 3 stated that their school grounds have 70% artificial versus 30% concrete (20% real greenery versus 80% concrete). This shows that some schools are trying to replicate nature, whether this has the same well-being effects as real nature is an area for further research to be conducted. All the teachers agreed that there is a need for more external and internal nature to be incorporated into the school grounds. Two teachers suggested that this could also be incorporated into the curriculum. Incorporating nature into the curriculum may be another way of improving well-being among students as Lindemann et al., (2021) found that the weekly amount of time spent in natural places and on plant care was positively associated with children's feelings of comfort and learning satisfaction. In addition, time spent in nature was negatively associated with children's feelings of stress and lack of concentration during lessons (Lindemann et al., 2021). Lastly, one teacher noted that their school has implemented green walls in three classrooms (one year group), this shows that it is possible to implement green walls into elementary schools in London.

The findings of Chang and Chen (2005) (Study N7) suggest that a window view of nature or a cityscape has more of a positive impact on anxiety levels than indoor plants. There is a large contrast between the anxiety levels noted in Han's (2008) (Study I25) and Chang and Chen (2005). A vast difference in the two studies was the office/school set ups. Chang and

Chen's (2005) use of virtual reality to generate the office images in comparison to Han (2008) who used real life plants could be one explanation for the large differences in anxiety levels noted between the two studies. In addition, Han (2008) does not confirm what window view the students have within the classroom, the findings of Chang and Chen (2005) suggest that window views can have an impact on anxiety levels making this information of high importance. Another limitation of Han's (2008) study which could explain the low anxiety readings is the location of the plants. These were placed at the back of the classroom meaning students had limited visibility. The findings from these two studies highlights the need for further research to be conducted to confirm the role and importance that visibility of the nature elements have on anxiety.

In addition, Chang and Chen (2005) found that participants had reduced stress levels when in the presence of a window view of nature plus indoor plants. These findings are similar to those found in the literature review from Li and Sullivan's (2016), who noted that green views produce better attentional functioning and a greater recovery from stress. However, it is also important to note that the mean score for the EEG in the presence of a window view of nature plus indoor plants in Chang and Chen's (2005) study was 0.92 μV higher than any other measurement obtained within the study. This highlights the need for further research to be carried out to ensure this measurement is not an anomaly. In addition, further research is required to reconfirm the measures obtained during Chang and Chen's (2005) study as in total. 6 of the measurements obtained in the experimental groups (OP EEG-a and EEG-b, C EEG-b, CP EEG-a and EEG-b and N EEG-b) were all lower than the two measurements obtained during the control group. Overall, only 4 measurements were higher than the measurements obtained during the control group. Whereas all the measurements obtained during the intervention group of Elsadek and Liu (2020) (Study I31) were above those noted in the control group. The findings from Elsadek and Liu (2020) suggest that stress levels are

reduced in the presence of indoor plants, and that blue flowers reduce stress levels more than purple flowers.

The findings on the impact of nature elements on well-being were inconclusive and require further research. Thatcher et al., (2020) (Study I4) looked at the impact of indoor plants on employee well-being, however the measurements obtained in the intervention group for both studies were lower than those noted in the control group suggesting that indoor plants do not have an impact on employee well-being. In addition, van den Bogerd et al., (2020) (Study I20/G2) looked at the impact of indoor plants on university student's well-being and found that potted plants and flowers do not impact fatigue but do have an impact on stress levels. However, these positive findings were only noted 2 weeks after introduction of the indoor plants and were reduced to below control group measurements after the 5-week mark. This suggests that indoor plants do have an immediate impact on the stress levels of university students but not office employees. In addition, Lindemann-Matthiers et al., (2021) noted in the literature review found that more natural window views were associated with less perceived stress among the participating elementary school children. The discrepancy in findings between students and office employees suggests that nature elements could have more of a beneficial immediate impact on student's stress levels as appose to office employees.

The studies that looked at mood found similar immediate positive impacts of nature elements as those found in the stress studies. Van den Borgerd et al., (2020) (Study I20/G2) recorded the highest mood measurement 2 weeks after installation of the green wall. However, the positive effect was reduced at the 5-week mark. Overall, the green wall was noted to have a more positive impact on mood than potted plants, with potted plants only increasing mood measurements slightly at the 2-week stage. The mood measurements for potted plants at 5-weeks were the lowest measurements recorded during the whole study. This again further

supports the suggestion that nature elements have an immediate positive impact on well-being, often noted at the 2-week stage but depletes as time goes on. Shibata and Suzuki (2004) (Study I18) also noted an immediate impact of indoor plants on participants calmness, however these measurements were significantly reduced post task. Shibata and Suzuki's (2004) findings suggest that indoor plants can have a calming effect on students however, once distracted with a task these effects decrease. In contrast, Najafi and Kehmiri (2018)(Study I9) found indoor plants do have a positive impact on happiness levels of female students with the highest measurements being obtained 12 weeks after installation. The positive impact of indoor nature on female participants was also noted by Shibata and Suzuki (2004) who found that female participants performed better when the plant was in the room compared to when the magazine stand was in the room. However, this correlation was not noted with the male participants. This highlights the need for further research to be conducted to confirm whether nature elements have more of an impact on females.

All the studies that carried out measurements immediately after installation of a nature element reported positive findings. However, as the length of exposure increased the positive impact decreased. Han (2008) noted a slight decrease in anxiety levels in the intervention group after a semester, however Chang and Chen (2005) noted a positive immediate impact. In addition, Thatcher et al., (2020) (study 1 and 2) did not note a positive impact on well-being after 12 weeks and 17 weeks, but van den Bogerd et al., (2020) did note an immediate impact on fatigue levels but these findings were reduced to below control group measurements by 5 weeks. Van den Boerd et al., (2020), (study 1 and 3) both noted positive impacts 2 weeks after installation, but the positive impacts were not noted 5 weeks after installation. These findings suggest that nature elements have an immediate impact on well-being which is still present after 2 weeks but decreases between 2-5weeks. However, Najafi and Keshmiri (2018) (Study I9) noted a positive impact of indoor plants on happiness after 12

weeks, which raises the question of whether the positive impact of nature is felt more long term in females.

Overall, only three studies out of eight found a significant difference between the control group and intervention group highlighting the need for further research to be conducted to explore whether gender, educational status (whether a student or office employee) and visibility of the nature elements plays an important role on its impact and length of impact.

5.1 Conclusions

This study found that there is a need for more nature elements to be introduced to London elementary schools. Two elementary schools have used artificial greenery to try and balance out the levels of concrete and greenery currently present on the school grounds. Further research needs to be conducted to see if artificial nature elements have any positive impact on well-being. In addition, this study found that nature elements have an immediate positive impact on well-being which supports Attention Restorative Theory (ART) and Stress Recovery Theory (SRT) theories. However, the findings suggest that the well-being benefits of nature elements decreases somewhere between 2-5 weeks.

Furthermore, it found that a cityscape window view has more of a positive impact on anxiety and stress than indoor plants.

Further research is required to see whether the impacts of nature elements on well-being are prolonged if the students have more of an interaction with the element (e.g. incorporating this into the curriculum). Furthermore, the study has noted a more positive impact on female participants, however further research is required to confirm these findings.

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