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Plants in the Classroom Can Improve Student Performance

John Daly[1], Margaret Burchett[2] and Fraser Torpy[2]

[1] Eco-Environment – Unit 3 /5 Deakin Street, Brendale. Q, 4500, Australia.

[2]Plants and Indoor Environmental Quality Group, Centre for Environmental Sustainability, Faculty of Science, University of Technology, Sydney (UTS) Australia.

john@ecoenvironment.com.au Margaret.Burchett@uts.edu.au

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Summary

Many studies in the past have shown that plants and Growing media (as a Biofilter) maintained indoors improve air quality, ambiance and mood of workers resulting in improved staff productivity, performance, job satisfaction and reduced sick leave absence, stress, depression and negative mood states. However, only few studies on classroom performance of school children have been conducted so far. To understand the performance of students in classrooms with and without Potted plants, we conducted the first Trial study involving 360 students in grades six and seven in 16 classes in three schools in Queensland, Australia and student performance was tested across three curriculum course streams: Numeracy, Literacy and Science. The results indicated that the presence of plants and long-term specialist growing media in the classroom consistently led to improved performance in spelling, mathematics and science – i.e., across the curriculum (by removing VOCs from the air). The results were statistically

significant with 10 to 14% improvement in all but one of the five sets of scores in two schools, whereas in the third school where results were not significant between groups with and without plants' presence, the students were already involved in an active gardening program, involving both ornamental and vegetable species.

Therefore, it can be concluded that the presence of plants in the classroom environment improves student performance.

INTRODUCTION

Numerous studies have now shown conclusively that indoor plants improve many aspects of indoor environmental quality, including cleaner indoor air quality, increases in staff productivity, performance and job satisfaction, and reductions in sick leave absences, and feelings of stress, depression and other negative mood states (for review, see, e.g.., Burchett et al., 2010). However, there has been almost no research conducted on the potential benefits to school student wellbeing of indoor plants in their classrooms. In fact, we have been able to find only two reports of any such studies. The first study, conducted in Sweden (Fjeld, 2002) found that potted-plants reduced sick-leave absences among primary school children. The second report was from a Taiwanese study (Han, 2009), which found that both class marks and behaviour in junior high-school students were improved when plants were installed in the classroom. However, the second study involved only two classes (one with, one without plants) and the researchers conceded that a variety of other factors (e.g. a more engaging teacher?) might account for the differences reported.

Plants in the room, however, have been found to improve performance in university students (Shibata and Suzuki, 2004), and lower their feelings of physical discomfort (Lohr and Pearson-Mims, 2000). Also, in one other study the performance of tertiary students was compared in classrooms with and without plants (Doxey and Waliezek, 2009). In this case, the authors reported that, although grades were not significantly affected by plant and potted media presence, there were significant differences in student satisfaction ratings. Those with planted classrooms rated their lecturers more highly on organisation and enthusiasm, than those in the group without media and plants, indicating perhaps that both staff and students were happier with plants in the workspace.

The aim of the current study was to investigate the effects of indoor plants and potting media on classroom performance in composite classes of Year 6 and 7 (i.e. Mid School and Senior Primary) students in three independent schools in the Brisbane region, Australia with a total of over 360 students in 13 classes.

Note some 2 months were needed to process and formulate the test structure of different school education systems, School Curriculum's across three varied school cultures, to maintain a standard Testing method across 3 curriculum course streams, (for trial credibility and consistency) in Numeracy , Literacy and Science (SOZ).

The three schools include:

A) **All Saints School** – Principal contact Steven Mongomery, Albany Creek, Brisbane North, Queensland, (3 classes each of Grades 6 and 7 with an average 25 pupils (150 total).

B) **All Saints Middle School, Merrimac** – Principal contact Sue Daly, Gold Coast, Queensland. (Middle school – 4 classes120 pupils, Grades 6and 7).

C) **St Joseph's School** – Main contact Dianne Pennings Beenleigh, Loganlea, Queensland (3x grades 6and7- 90 pupils).

METHODS

Human Ethics approval for the project was first obtained for the schools concerned. Then half of the participating classes each received a total of 6 plants in Specialist Growing Media in 200 mm pots, while the remaining classes received no plants.

Plant species were supplied by-Sharon Prater and Nick Holt at Advance Plant Services and also Stockade Nursery. Plant containers were supplied by Trevor Murphy at Container Connections and Sid Dyer at A2Z Planter Technology. Planting media was supplied by eCo-Environment as Bioganic Earth Podium indoor blend (Specialist Long-term Growing Media).

Each Classroom was supplied with the same species of three plants to maintain consistency. The plant species and numbers used were as follows: One each of 300mm Staked – *Rhaphidophora aurea* (*Scindapsus*, golden pothos), 250mm *Spathiphyllum* spp. 300mm and *Dracaena fragans* ('Janet Craig').

Students were tested with standard tests before plant placements and re-tested after about six weeks of plant presence (or absence). Test measures included spelling (South Australian Spelling Test, SAST) and mathematics in all three schools, while in one school tests of benchmark reading, and in another school tests in science, were also included.

RESULTS

Differences in student responses were found among the three schools. Students in two schools showed marked improvements in scores in spelling and maths in classrooms with plants present. However, in the third school no differences were found, in spelling, maths or reading, among classes with plants and those without. A comparison of results for the two schools showing improvements with plants present is presented in **Table 1**. For all but one of the five sets of scores influenced by plant presence, the improvements ranged from 10 to 14%.

In comparing planted to unplanted classrooms, two schools showed positive responses in scores with plant presence (**Figs. 1 to 3**). In School A, baseline scores were similar across the classrooms before plants were installed. At mid-term, classes with plants showed higher scores than those without (**Fig. 1**). Then by the end of term, though both sets of classes had further progressed, as would be expected, the classes with plants retained their lead over those without. The end of term results for spelling showed a parallel difference between the two groups of classes (**Fig. 3**).

Table 1. Summary of percentage differences, in each of two schools, in scores on three standard tests, in classrooms with and without plants (Means± Standard Error); 3 classes per school per treatment; totals 70 to 80 students per treatment.

Tests/Differences in scores		% increase in scores with plants present
Mathematics		
	School A	14 (±1.2)*
	School B	5 (±0.8)
Spelling		
	School A	10 (±1.5)*
	School B	12 (±1.7)*
Science		
	School B	11 (±1.2)*

*Signifies difference is statistically significant ($p \leq 0.05$).

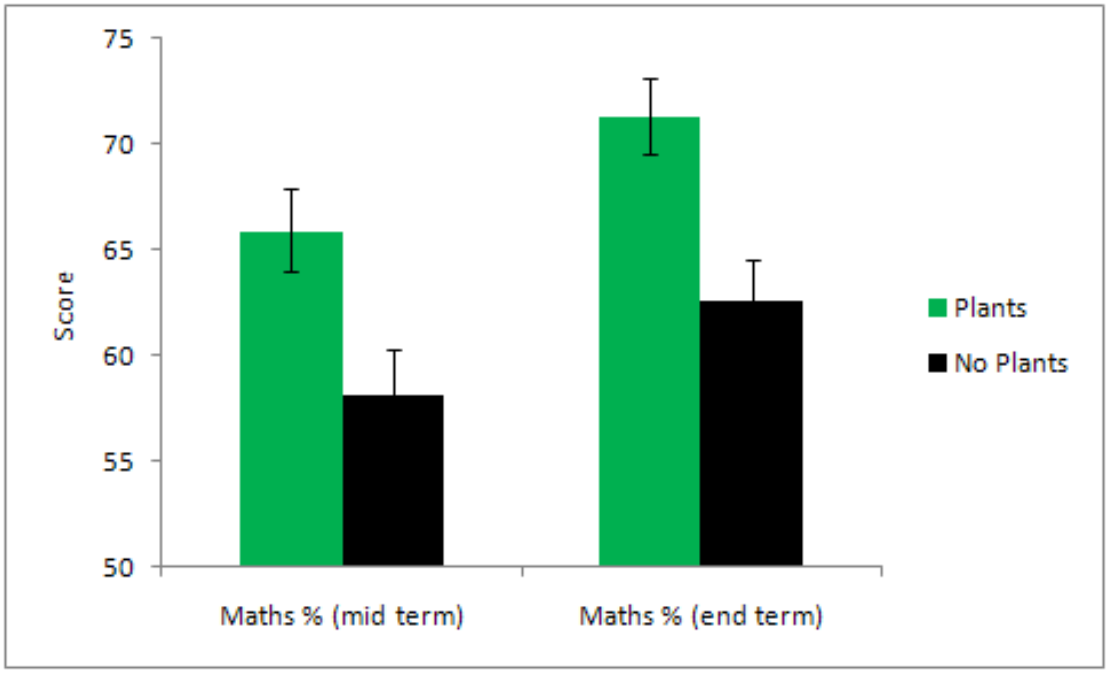

Figure 1. School A (All Saints Albany Creek): Comparison of changes in mid-term and end of term maths scores, in classes with and without plants. (Means and SE; n = 69–72.)

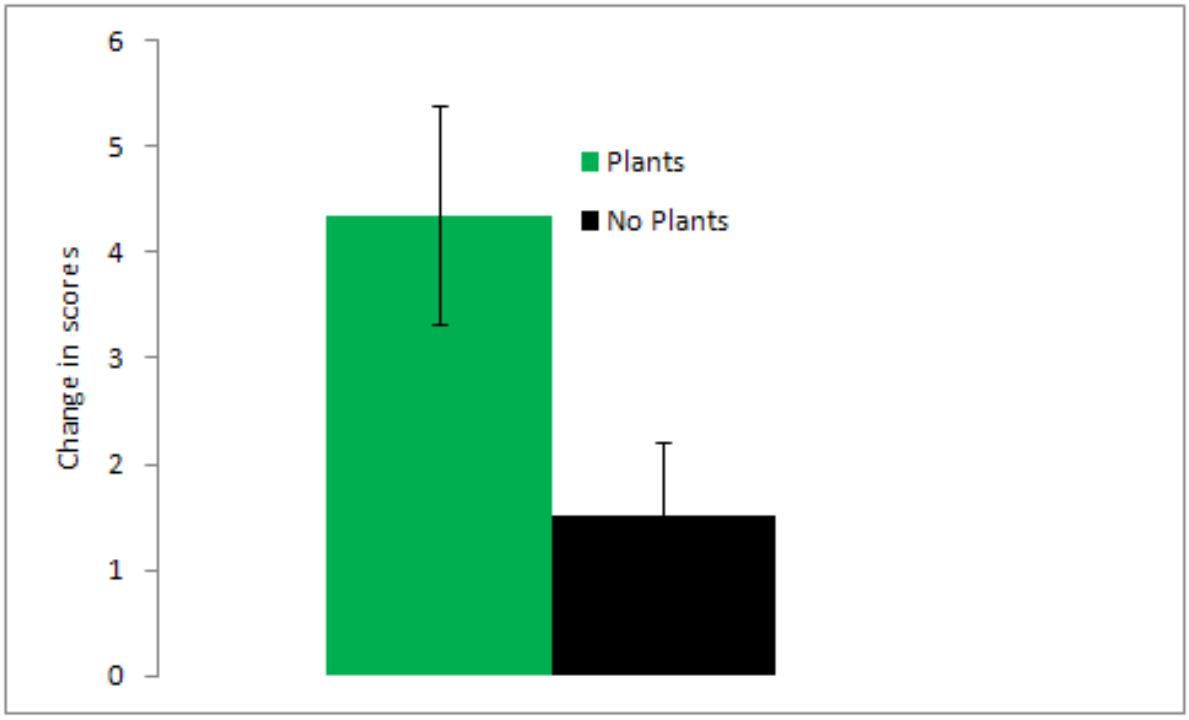

Figure 2. School A (All Saints Albany Creek): Comparison of end of term spelling scores, in classes with and without plants. (Means and SE; n = 69–72.)

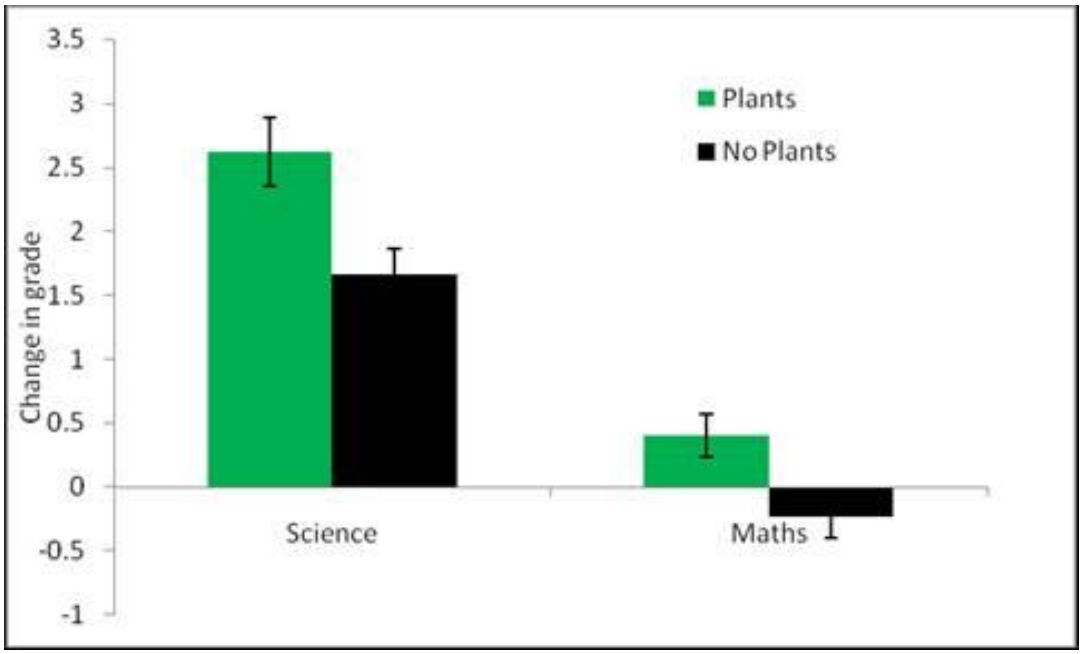

Figure 3. School B (All Saints Anglican Gold Coast): Comparison of end of term Science and Maths grades, in classes with and without plants.(Means and SE; n = 149.)

The results for School B for the end of term science and maths tests showed an improvement in both subjects with plants in the classrooms (**Fig. 3**). The slightly lowered score for maths for the non-plant group is not in itself significant, but the difference between that group of classrooms and those with plants is a statistically significant difference.

DISCUSSION

Because of the number of classes and students involved, it would appear that the differences can be accepted as real improvements in classroom performance resulting from plant and Specialist growing Media presence. Improvements in performance on the fundamental tasks of spelling and mathematics of 10% and more, are generally regarded by educationists as significant in students' progress in school.

How Might Such an Influence of Plants in the Classroom Come About?

First, research has shown that plants can significantly improve indoor air quality in office buildings (with or without air-conditioning). Research at University of Technology, Sydney (UTS) has shown that two or three plants in an office can significantly reduce levels of CO_2 and air-borne volatile organic compounds (VOCs) that are continually outgassing from plastic/synthetic surfaces (furnishings, fittings, equipment eg computers, copiers etc). These are the two major types of contaminants always found in higher concentrations indoors than outside, even in the CBD. However, the participating teachers indicated that, in this case, doors and windows of the classrooms were very often all open, so that this health benefit of plants might not have had much effect on the results obtained. However, the effects may well be found to be significant in winter, in closed classrooms with flueless gas heaters, since raised CO_2 levels causes loss of concentration and drowsiness.

Secondly, other studies have shown that indoor plants improve performance and productivity in adult workers (Lohr et al., 1996,). Also, a UTS study with 55 participants (university staff) showed that office plant presence had strong psychological benefits in reducing stress, anxiety and low spirits in adults. Other research indicates that nearby greenery resets our 'calm' button (Kaplan and Kaplan, 1990), and that indoor plants are also directly attractive, evoking positive responses among building occupants. In this study we found, on visiting the schools, that teachers and students showed great interest in having plants in their classrooms. Students of one class had even named their plants – 'Luigi', 'Mojo', 'Napoleon' and so on.

Urban living involves what has been described as a "disengagement with the natural environment". Re-establishing 'better links with nature' has become an important international public health concern (Maller, *et al.*, 2005; Frumkin, 2001; Kellert and Wilson, 1995; Kaplan, 1995; Wilson, 1984). Evidence shows that, for city dwellers, time spent in city parks and nature reserves is beneficial to health and wellbeing, with improvements in such physiological measures as blood pressure, and psychological measures as 'mood states' (Velarde et al., 2007; Hartig, *et al.*, 2003; Herzog et al., 2002). 'Park time' has also been shown to improve concentration performance in children with attention deficit disorders (Taylor and Kuo, 2009).

In the last two decades of the 20th century the 'Biophilia' hypothesis was introduced into environmental psychology (Wilson, 1984; Kellert and Wilson, 1995. This is the proposition that "humans have an inherent inclination to affiliate with nature" (Grinde and Patil, 2009). In line with this hypothesis, that a love of greenery and pets has very deep roots in our being, it seems to us that it is no random chance that three of the top favourite family websites include gardening, weekend get-aways, and fishing, all 'back-to-nature' pursuits. A possible reason, therefore, for the finding that School C showed no differences in performance in classes with or without plants, is that this school has an active gardening program, involving both ornamental and vegetable species. Indeed, these classes have on occasion sold their vegetables to parents and friends of the school, the money raised being spent on excursions or new materials and activities for the classrooms. It is possible, then, that in this school a continuing contact with nature is already being satisfied, and the classroom plants are just a pleasant extra. One teacher here, however, reported that, when children were asked to sit and read quietly or form small groups to discuss some topic, they tended to cluster on the floor around each of the plants.

In summary, the results indicate that, for possibly a variety of interlinked reasons, classroom plants consistently led to improved performance in spelling, mathematics and science – i.e., apparently across the curriculum. This was a preliminary study – the first of its kind in attempting to compare the performance of class populations of school students in classrooms with and without indoor plants, and follow-up studies would be needed for formal confirmation of the changes found here. However, taking the other relevant research evidence into account, and since in our informal discussions at the three schools there seemed to be unanimous agreement among teachers and students that plants in the classroom improved its appearance and 'ambience', a recommendation for indoor plants to be a standard installation of school classrooms appears justifiable and timely.

Plants in the classroom could also be used as a teaching tool in biological science (observations on growth, and flowering, e.g. in *Spathiphyllum*; consideration of the requirements of maintenance and growth; caring for a living organism; comparison of high-light vs low-light plants; geography of origins of various species; environmental principles for vegetation conservation; etc.). A recent Japanese article on the issue of changes in school curricula in that country since the second world war, deplored the reduction of any studies developing 'nurturing' or 'fostering' concepts, with practical demonstrations, e.g. in caring of small animals or plants. The same trends may also have occurred in Australia. The schools garden programs that are growing in this country, could be augmented by the inclusion of indoor plants.

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Plant materials were supplied by Sharon Prater and Nick Holt @ Advance Plant Services and also Stockade Nursery. Plant containers were supplied by Trevor Murphy @ Container Connections and Sid Dyer @ A2Z Planter Technology. Specialist Planting Media (Bioganic Earth- Podium Blend) supplied by eCo-Environment.

Author Contributions

John Daly- Initiated the Trials with Prof. M. Burchett, facilitated the negotiation process of different Education systems, School Curricula across three varied school cultures, to maintain a standard testing method across three curriculum course streams, (for trial credibility and Consistency) in Numeracy, Literacy and Science (SOZ).

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