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The effect of indoor plants on students' effective learning levels

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ABSTRACT

The purpose of this study is to examine the role of indoor plants on students' learning levels. The study group consists of students studying in the Department of Interior Design at Zonguldak Bülent Ecevit University Çaycuma Vocational School. It was determined by the course instructor (researcher) that there were 40 interior design students in the 2024-2025 Spring semester when the study was conducted. A survey was administered to determine the effective learning levels of students in environments with and without plants. The survey was conducted in two stages. In the first stage, 30 students who participated in the study were given a lesson in an empty classroom and were asked to evaluate their learning in this classroom. In the second stage, indoor plants were placed in a classroom for the students. The placed plants remained in the classroom where these students were taking lessons until the end of the semester. The survey mentioned above was applied again at the end of the semester. The analyses revealed a significant difference between students' pre- and post-test scores regarding effective learning. Based on this result, it can be concluded that the use of indoor plants in classrooms significantly impacts students' learning levels.

Contribution/ Originality: The study findings indicate that the use of plants in indoor spaces positively contributes to individuals' psychological well-being, physical health, happiness, and overall quality of life, thereby enhancing their learning processes. Consequently, the integration of indoor plants should be promoted across all living environments, particularly within educational institutions. Given the limited number of such studies conducted in Turkey, it is anticipated that our research will significantly contribute to this field of knowledge.

1. INTRODUCTION

The use of plants in interior spaces has a long history. Historical sources indicate that this practice was adopted by the Egyptians in the 3rd century BC; and the Pompeii ruins reveal that such arrangements were encountered more than 2,000 years ago. This use became more widespread in the second half of the 20th century. The reasons for this increase include the decrease in the transportation and production costs of tropical and subtropical plants, changes in interior design, and the ability to grow these plants in more northern latitudes as higher temperatures can be maintained. Today, plants are used in many parts of the world in homes, workplaces, waiting rooms, shopping malls, restaurants, hotels, schools, and many other public and private spaces [1].

Indoor plants are plants that are artificially provided in pots or various containers, taken out of their natural ecological environments, and can survive in indoor spaces similar to their own growth and development environments, and have flowers or leaves or both [2, 3]. These plants exhibit unique aesthetic and functional features in their environment, characterized by showy flowers, fruits, branches, and leaves [4]. Plants are widely regarded as

essential elements of a healthy indoor environment and are commonly incorporated into settings such as offices, hotels, waiting areas, restaurants, classrooms, and other enclosed spaces [5]. Therefore, interaction with plants has been shown to support various aspects of well-being, including enhancements in physical health, cognitive abilities, mental health, and social functioning [6, 7].

One of the areas where plants have psychological effects is the learning process. Learning is defined as the process of changing people's values, beliefs, attitudes, and behaviors in line with the information obtained from theoretical thoughts, practices, and experiences [8]. Learning may also be defined as a process of developing understanding that leads to changes in attitudes and behaviors through the acquisition of knowledge, skills, and values gained from study and experience [9]. A change in an individual's behavior occurs through learning. This change occurs through the mutual relationships that the person establishes with his/her environment. Learning can be defined as long-term changes in behaviors that occur throughout a person's life [10]. Learning is the acquisition, understanding, and assimilation of knowledge and skills by individuals [11].

The phenomenon of learning has social and psychological dimensions. While individual learning constitutes the psychological dimension, the maturation of the learned information through a filter and learning in a group constitute the social dimension of learning [12]. Nowadays, as educational institutions encounter more complex problems, they feel the need to create and develop their existing or non-existent skills in group learning. It can be said that groups have a greater potential for intelligence compared to the intelligence of individuals. In this sense, group learning refers to the sum of the intelligences of the individuals in the group thinking together, analyzing the current situation, and designing the future. In addition, it can be said that groups contribute to the development of a sense of collective responsibility and pave the way for individuals to reveal their learning skills [13]. In addition to the benefits of learning together, it is reported in studies that the environment in which learning takes place also affects individuals' learning processes [1, 14-17]. However, no studies have been found in Turkey on the use of plants in learning environments and their effects on students' learning achievement. Due to the serious deficiency detected in this area, this study examines the extent to which the use of indoor plants in classrooms affects students' effective learning levels. However, studies on the use of plants in learning environments and their impact on student learning are almost non-existent in Turkey. Due to this significant gap in this area, this study examines the impact of using indoor plants in classrooms on student learning.

2. THEORETICAL FRAMEWORK

2.1. Definition of Learning

Human behavior is not random but purposeful. This aspect of human behavior is explained by certain driving forces underlying it. These driving forces are generally called motivation. A motivation is an awakened need. Motivation is the activation of this need [18]. The process that results in a relatively permanent change in behaviors or potential behaviors in line with motivation, through experiences or repetition, is called learning [19, 20]. It is possible to define learning as a behavioral change that occurs as a result of a certain level of interaction that people have with their environment and that has relatively permanent traces [21]. In another definition, learning is evaluated as the process of change in people's values, beliefs, attitudes, and behaviors created by information combined from theoretical thoughts, practices, or experiences Sökmen [22]. According to Özkalp and Kırel [23], learning is the change that occurs in the behavior of an individual. This change occurs as a result of the relationship between the individual and the environment. Accordingly, they consider the change that occurs in behavior as the best evidence of learning. Learning is a complex process that includes motor, cognitive, affective, and neurophysiological changes that occur in the individual along with the interaction between the individual and the environment [23].

Learning is the process of acquiring new information and thinking systems that lead to changing behaviors in order to achieve desired results. This process involves renewal and change [24]. The main purpose of learning is for individuals or groups to gain the ability to cope positively with the changes that force them to adapt [22]. At this

point, it is possible to evaluate learning as a phenomenon that triggers competitiveness, productivity, and innovation in a world where the technological environment and market conditions are uncertain, and to maintain and develop this situation [25]. It is known that learning, an important phenomenon, affects people's abilities, role perceptions, motivations, and individual behavioral performances. When considered in terms of abilities, it can be said that learning influences individuals in both formal and informal contexts [26].

Learning is a process influenced by, and simultaneously influences, many psychological, physical, social, and environmental factors [27]. Learning as a process means that it is continuous, passing through specific stages and steps within a specific timeframe. Therefore, the aforementioned elements contribute to learning that is, acquiring new behaviors, attitudes, experiences, skills, and knowledge depending on the degree to which they influence [28]. It is necessary to define some terms for the process to be understandable. These are four concepts: drive, stimulus, response, and reinforcement. A drive is the condition in which an organism seeks to satisfy a need. It is the evoked or willing condition necessary for an action or behavior to begin. A stimulus is a sign or signal that initiates a response. It is generally conveyed through sight, hearing, smell, and touch. A response is the behavior resulting from a stimulus (even if it is not possible to define the stimulus). Reinforcement is any event or object that strengthens a response by providing some kind of reward to the organism or by causing the response to continue or increase [29].

Learning is carried out at multiple levels. These levels are interconnected and create a synergy [30]. Individual learning refers to the process by which an individual acquires new information, understands it, interprets it, evaluates it, and adjusts their behaviors based on the results [31]. Therefore, it can be said that intuition and interpretation are personal events, and therefore it would be more accurate to say that individuals intuit and interpret on behalf of groups and organizations, not groups or organizations [20]. Group and organizational learning are metaphors derived from individual learning. Individuals who learn at an individual level share what they have learned within the group, interpret it together, and reach a group understanding, which is called group learning [32]. Groups carry out learning as a result of the activities and interactions of individuals working in small teams. In this respect, it can be said that learning groups serve as an important link between learning individuals and learning organizations [33]. Groups and organizations are systems consisting of individuals. Therefore, individuals are the cornerstone of group and organizational learning. Although individual learning does not guarantee learning at group and organizational levels, it is stated that they can learn through individuals who learn. Therefore, it is not possible for learning at other levels to occur without learning at the individual level [30].

2.2. The Role of Indoor Plants in Learning

For centuries, nature has been thought to have healing potential. Plants, sunlight, and other natural elements have been used as therapeutic aids to improve the environment [7]. In later periods, the relationship between humans and plants has been discussed in terms of theoretical concepts such as learning, evolution, and overload/stimulation [6]. In this context, indoor plants have been evaluated as important design elements that can directly affect human health and performance [3]. Indoor plants improve the aesthetics of homes and work environments while allowing people to live in greener spaces. The need for ornamental plants has become important for people's general well-being, as looking at a blooming flower or a tree in nature increases happiness [4]. It has been reported that indoor plants improve mood, reduce stress, increase productivity, enhance individuals' reaction speed, improve attention span, improve the air quality of the environment they are in, reduce blood pressure, and decrease fatigue and headaches [5, 17, 34]. From the perspective of students, it is suggested that having plants in the classroom, as well as keeping classrooms well-lit using natural sunlight or full-spectrum lighting whenever possible, contributes to the learning process of students [15].

Students' learning outcomes are influenced by a range of factors. One of these is intellectual factors, which relate to individual cognitive challenges such as low intelligence quotient (IQ), lack of interest in certain subjects, or emotional immaturity. Another important category is learning-related factors, which encompass both students'

difficulties in understanding instructional content and teachers' inadequate subject knowledge. Additionally, the use of ineffective teaching strategies or students' limited prior knowledge can hinder the learning process. Physical factors also play a critical role, including students' overall health, nutritional status, sensory or physical impairments, and stages of physical development, all of which can contribute to learning difficulties [9]. Furthermore, the learning environment itself has been shown to impact educational experiences [1]. Given that students spend a substantial amount of time within classrooms, these spaces are considered vital components of the educational infrastructure [35]. Consequently, classrooms should foster calmness and focus; activity areas should be stimulating; administrative offices should convey formality; and corridors should promote movement and engagement [36].

Lohr and Pearson-Mims [14] stated that plants have a greater ability to hold attention in such spaces and encourage learning more than other aesthetic facilities (e.g., desk lamps, abstract paintings). They also found that spaces with plants are more cheerful, pleasant, and inviting than spaces with other aesthetic facilities. Dinsmore [15] conducted a randomized study investigating how students perceive the influence of classroom elements such as plants, lighting, and music on their behavior. When questioned about the impact of these factors on their learning, 43% of the participants indicated that the presence of plants contributed to a more relaxing and comfortable classroom environment. Kellert [16] stated that indoor plants promote physical capacity, material comfort, emotional maturation, creative ability, moral belief, spiritual meaning, intellectual development, and learning. Again, Doxey et al. [17] found that plants affected students' learning levels in the classroom. These studies are important because they reveal that the use of indoor plants in learning environments positively regulates students' attention deficit, concentration, and cognitive performance. In a study conducted in three different schools, Van Den Bogerd et al. [37] found that secondary school students who studied in environments with plants had higher attention levels and more positive opinions about the course and the teacher. Barbiero et al. [38] found that learning environments with biophilic designs were preferred as more relaxing and were perceived more positively. Furthermore, it has been reported that such classrooms have a greater impact on student performance compared to traditional learning environments. Jung and Awad [37] found that students in areas with indoor plants perceived indoor air quality as 40% cleaner and 140% more acceptable. Furthermore, it was found that there was a 108% decrease in the complaint rate of students with specific problems, and students' focus on learning increased by approximately 120%. As seen in these studies, plants have been stated to have a natural relaxing effect, and green plants in classrooms can reduce students' stress levels. Environments enriched with natural elements (such as plants) have been reported to increase attention span. Plants absorb carbon dioxide, produce oxygen, and filter out some toxins, thereby improving classroom air quality. This, in turn, positively impacts mental performance. Natural environments help people recover more quickly from mental fatigue. In this sense, plants create a "micro-nature" effect. Contact with nature can foster creative thinking and problem-solving skills. A plant-filled environment appears warmer and more inviting, contributing to students' sense of well-being in the school environment.

3. MATERIAL AND METHODS

In this section of the study, after providing basic information about the research area, details are given regarding the plants placed in the classrooms, the study group participating in the research, and the data collection process. The information concerning the implementation process of the research is as follows:

3.1. Field of Study

Çaycuma Vocational School, where the study was conducted, is a higher education institution established in 2001 to train technical intermediate staff affiliated with Zonguldak Bülent Ecevit University. Çaycuma Vocational School continues its education and training activities with 8 departments, 13 associate degree programs, and over 2000 registered students. The school provides theoretical education reinforced with practical application opportunities in various programs such as office services, mining, forestry, design, transportation services, and foreign languages. The

school adopts an application-based approach and is open to cooperation with the sector. The classroom where the application is carried out offers a very bright and spacious learning environment suitable for both practical and theoretical courses. The classroom is 325 m^2 and has a large volume, with a podium at the front for instructors to place their computers and documents, and seating units for three students. Large windows in the space enhance natural lighting, keeping the classroom bright and creating a conducive learning atmosphere. The ceiling height is quite high, reinforcing the sense of spaciousness and potentially positively affecting student attention and motivation. The walls are white, minimizing distracting stimuli and helping students focus more on the lessons.

3.2. Classroom and Plant Placement

Classes were held in a designated classroom for Interior Design students during the semester. In the classroom, since the visibility of the plants for some students may have been limited by the seating, an attempt was made to place other plants at appropriate points around the classroom. Student seating was not assigned, and students were given the option to sit in any available seat in all classrooms throughout the semester. In Figure 1 the empty and planted classrooms are shown.

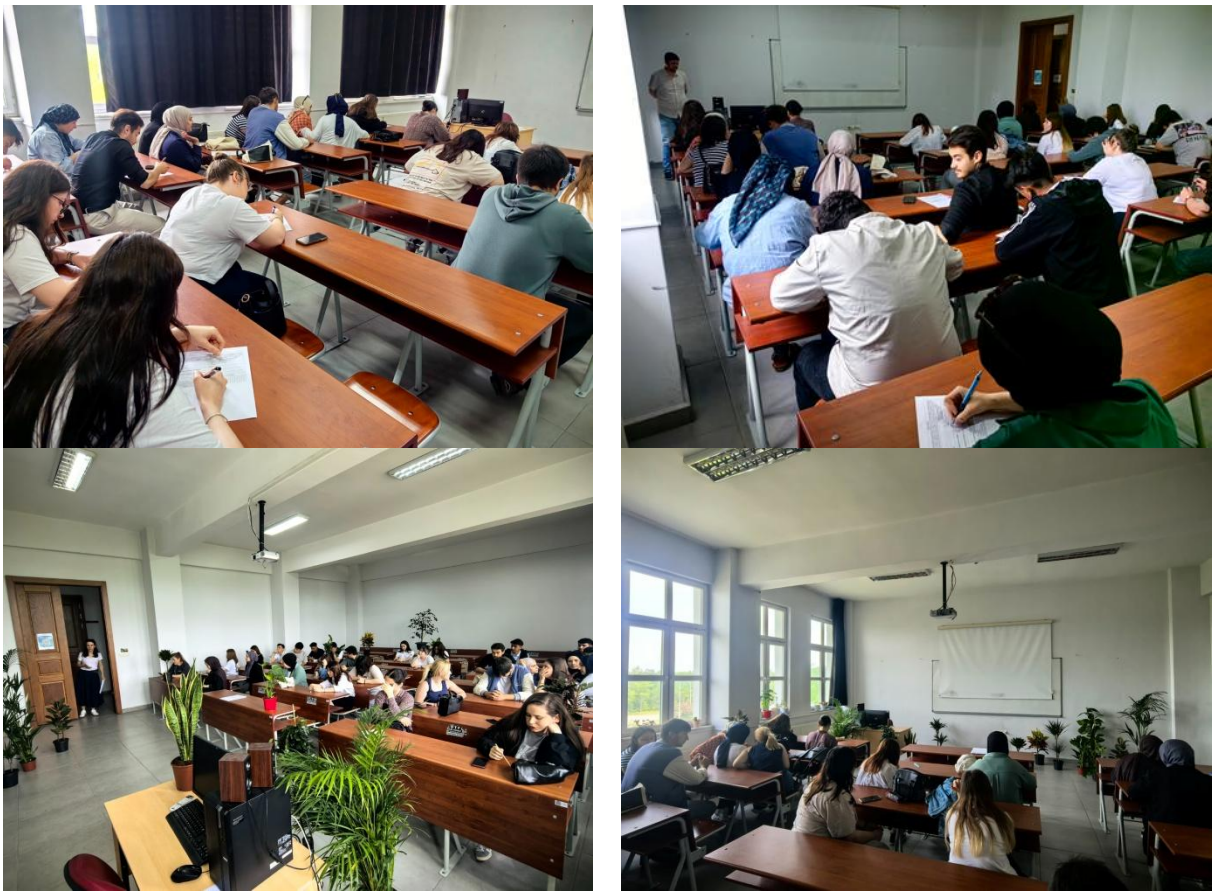

Figure 1. A view from a plant-free and planted classroom.

In the classes, a total of 17 indoor plants were used, including *Dracaena Marginata*, *Dracaena reflexa*, *Aglaonema* sp., *Epipremnum aureum*, *Dypsis lutescens*, *Chlorophytum comosum*, *Spathiphyllum wallisii*, *Dracaena trifasciata*, *Monstera deliciosa*, *Ficus benjamina*, *Chamaedorea seifrizii*, *Ficus elastica*, *Syngonium podophyllum*, *Nephralepis exaltata*, and *Calathea* sp.

3.3. Study Group

This study involves students enrolled in the Department of Interior Design at Zonguldak Bülent Ecevit University Çaycuma Vocational School. It was determined by the course instructor (researcher) that there were 40 interior design students in the 2024-2025 Spring semester when the study was conducted. The students who participated in the study were asked whether they believed in the contribution of plants to learning levels, and 30 students who indicated that plants had a positive effect were included in the study. Accordingly, 75% of the population participated in the research.

3.4. Research Process

The research is a randomized controlled study. A survey was conducted to determine the effective learning levels of students in environments with and without plants. In addition to the demographic characteristics of the students, the survey included four statements measuring the effective learning level of the individuals in question: (1) I found the course easy and stimulating, (2) I learned something I found valuable, (3) my interest in the course increased thanks to the classroom, (4) I learned and understood the subject materials in the class. The scale was taken from the studies of Doxey, et al. [17]. Scale statements were scored as 1-Strongly disagree; 5=Strongly agree. The survey was conducted in two stages. In the first stage, 30 students participating in the study were given a lesson in an empty classroom and were asked to evaluate their learning in this classroom. In the second stage, indoor plants were placed in a classroom for the students. The placed plants remained in the classroom where these students were taking lessons until the end of the semester. The survey mentioned above was applied again at the end of the semester.

Data Analysis: The collected data was analyzed with SPSS 22. In this context, firstly, the demographic characteristics of the students participating in the research were analyzed. Then, the first and last test scores related to learning were calculated. After calculating the scores, independent sample t-tests and one-way ANOVA tests were used for comparisons between groups. The findings were evaluated in the relevant sections of the study.

4. RESULTS AND DISCUSSION

In this part of the study, the findings of the semi-experimental research conducted on students of the Interior Design Department at Zonguldak Bülent Ecevit University Çaycuma Vocational School were analyzed and interpreted.

Table 1. General characteristics of the students.

Features	Variables	n	%
Gender	Male	20	66.7
	Female	10	33.3
Age	20 years old	10	33.3
	21 years old	9	30.0
	Ages 22 and above	11	36.7
Love of plants	Yes	27	90.0
	No	3	10.0
Allergy to plants	Yes	7	23.3
	No	23	76.7
Grand total		30	100

4.1. General Characteristics of the Students Participating in the Research

Table 1 presents the findings related to the students' general characteristics. To identify these characteristics, a frequency analysis was performed on the data obtained from the study participants.

Of the 30 students who participated in the study, 66.7% were male and 33.3% were female. 33.3% of the students were 20 years old, 30% were 21 years old, and the remaining 36.7% were 22 years old and older. 90% of the students

stated that they liked indoor plants. They also stated that 76.7% of the students were not allergic to indoor plants. Students with allergies wanted to continue participating in the application because they liked plants.

4.2. Findings Regarding Students' Effective Learning Level

Table 2 shows the findings regarding the pre-test and post-test scores. In this part of the study, the arithmetic mean and standard deviation levels of the answers given by the students to the statements regarding effective learning in the pre- and post-tests were analyzed. To determine the effective learning levels of the students, the following value ranges were used: 1.00-1.80 = strongly disagree, 1.81-2.60 = disagree, 2.61-3.40 = undecided, 3.41-4.20 = agree, and 4.21-5.00 = strongly agree [38]. Then, the scores regarding the learning levels of the students were compared.

Table 2. Pre-test and post-test results of students regarding learning.

Effective Learning Level	n	$\bar{X} \pm SS$	t	p
Pre-test	30	2.75±0.95	-5.203	0.000 *
Final test	30	3.70±0.84		

While the effective learning levels of students who study in a classroom without plants were found to be at a moderate level ($\bar{X}$ = 2.75), it was determined that studying in a planted environment significantly increased their learning levels ($\bar{X}$ = 3.70). Therefore, it was established that there was a significant difference between the pre-test and post-test scores of the study ($t = -5.203$; $p < 0.05$). According to this result, it can be concluded that the use of indoor plants in classrooms has a significant effect on students' learning levels.

The comparison results are given in Table 3. The pre- and post-test scores of the students regarding their effective learning levels were compared in terms of their gender.

Table 3. Comparison of students' learning levels in terms of gender.

Effective learning level	Gender	n	$\bar{X} \pm SS$	t	p
Pre-test	1. Male	20	2.78±1.00	0.300	0.766
	2. Female	10	2.67±0.89		
Final test	1. Male	20	3.63±0.97	-0.640	0.527
	2. Female	10	3.85±0.51		

Although there was an increase in the scores in the pre- and post-tests, it was observed that the learning levels of men and women increased proportionally ($p>0.05$).

Table 4. Comparison of students' learning levels according to their ages.

Effective learning level	Age	n	$\bar{X} \pm SS$	F	p
Pre-test	1. 20 years old	10	2.85±1.15	0.078	0.925
	2. Age 21	9	2.69±1.00		
	3. Ages 23 and above	11	2.70±0.73		
Final test	1. 20 years old	10	3.45±0.98	1.029	0.371
	2. Age 21	9	3.66±0.80		
	3. Ages 23 and above	11	3.97±0.74		

Table 4, the pre- and post-test scores regarding the effective learning levels of the students are compared in terms of their ages.

According to the pre-test results, no significant difference was found between the learning levels of the students ($p>0.05$). It was determined that while studying in a plant-filled environment increased the learning levels of the students, no significant difference occurred between the groups ($p>0.05$).

Table 5 compares the pre- and post-test scores of the students regarding their effective learning levels in terms of whether they like plants or not.

Table 5. Comparison of students' learning levels in terms of whether they like plants or not.

	Plant loving	n	$\bar{X}$ ±SS	t	p
Pre-test	1. Yes	27	2.81±0.94	1.125	0.270
	2. No	3	2.66±1.01		
Final test	1. Yes	27	3.70±0.90	-0.104	0.918
	2. No	3	3.75±0.28		

As a result of the pre-test, the learning levels of students who like and dislike plants were determined to be at a moderate level, and no statistically significant difference was found between their scores ($p>0.05$). In the post-test, although there was no significant difference between the scores of students who like and dislike plants, an increase in their effective learning levels was observed ($p>0.05$).

Table 6 compares the pre- and post-test scores of the students regarding their effective learning levels in terms of whether they are allergic to plants.

Table 6. Comparison of students' learning levels in terms of whether they have plant allergies or not.

Effective learning level	Plant allergy	n	$\bar{X}$ ± SS	t	p
Pre-test	1. Yes	7	3.07±0.42	1.022	0.316
	2. No	23	2.65±1.04		
Final test	1. Yes	7	3.66±0.87	-0.08	0.930
	2. No	23	3.71±0.86		

As a result of the pre-test, the learning levels of students with and without allergies to plants were determined to be moderate, and no statistically significant difference was found between their scores ($p>0.05$). Although there was no significant difference between the scores of students with and without allergies to plants in the post-test, it can be said that the education they received in a plant-based environment increased their learning levels ($p>0.05$).

5. CONCLUSION AND RECOMMENDATIONS

Students worldwide face various challenges throughout their education. The problems students experience during their learning process are rooted in many issues [39]. These problems, particularly those stemming from physical and psychological causes, can be addressed with indoor plants. Plants are recognized as essential components of a healthy indoor environment, commonly found in spaces such as offices, hotels, waiting areas, restaurants, classrooms, and various other enclosed settings [5]. Interaction with plants has been associated with a range of benefits, including enhancements in physical health, cognitive performance, emotional well-being, and social interaction [6, 7]. It is reported that indoor plants improve mood, reduce stress, increase productivity, increase individuals' reaction speed, improve attention span, improve the air quality of the environment they are in, reduce blood pressure, and reduce fatigue and headaches [5, 17, 34]. From an educational perspective, studies have shown that indoor plants used in classrooms where learning takes place also affect the learning processes of individuals. These studies have demonstrated that plants have a natural relaxing effect, and that green plants in the classroom can reduce students' stress levels. It has been reported that environments enriched with natural elements, such as plants, increase attention span. Plants absorb carbon dioxide, produce oxygen, and filter some toxins, thereby improving classroom air quality. This, in turn, positively impacts mental performance. Natural environments allow for faster recovery from mental fatigue. In this sense, plants create a "micro-nature" effect. Contact with nature can support creative thinking and problem-solving skills. A plant-filled environment appears warmer and more inviting, contributing to students feeling better in the school environment [1, 14-17].

In Çaycuma Vocational School sample, the effective learning levels of students taking classes in a classroom without plants were found to be at a moderate level. It was determined that taking classes in an environment with plants significantly increased their learning levels. Although there was an increase in the scores in the pre- and post-tests, it was observed that the learning levels of women and men increased proportionally. According to the pre-test results, no significant difference was found between the learning levels of the students. It was determined that taking classes in an environment with plants increased the learning levels of the students, but no significant difference occurred between the groups. As a result of the pre-test, the learning levels of students who liked plants and those who did not were found to be at a moderate level, and no statistically significant difference was found between their scores. In the post-test, although there was no significant difference between the scores of students who liked plants and those who did not, it was determined that there was an increase in their effective learning levels. As a result of the pre-test, the learning levels of students who were and were not allergic to plants were found to be at a moderate level, and no statistically significant difference was found between their scores. Although there was no significant difference between the scores of students who were and were not allergic to plants in the post-test, it can be said that the education they received in an environment with plants increased their learning levels. The study determined that indoor plants, a physical environmental factor, can directly impact students' cognitive, emotional, and motivational states. The findings suggest that students in classrooms with plants are more relaxed, focused, and motivated, and therefore able to process information more effectively. This finding demonstrates that educational environments should be designed not only pedagogically but also environmentally. Furthermore, the study's results suggest that learning environments integrated with nature support learning efficiency by enhancing students' attention, motivation, and information processing capacity. The findings obtained in this study confirmed the previous studies [1, 14-17, 37, 40, 41].

The research results indicate that the use of indoor plants in classrooms positively influences students' psychological well-being. Consequently, it is crucial to place indoor plants in educational settings to enhance mood, reduce stress, increase productivity, improve attention span, lower blood pressure, and decrease fatigue and headaches. This practice should be adopted across all educational institutions. The current study analyzed students' learning levels without differentiating between types of plants. Future research should explore which specific plants have more or less impact on students' learning. The study was conducted on the same sample group over a defined period. Longer-term studies incorporating control and experimental groups are recommended for more comprehensive insights. Additionally, this study assessed the impact of plants based on student perceptions. Future investigations employing different methodologies could produce varied results. For instance, comparative studies could analyze overall grade point averages of students in environments with plants versus those without. Wearable technologies could also be utilized to examine differences in learning levels and physiological characteristics such as heart rate and brain activity between students in planted and non-planted environments.

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Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

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