Chapter 10
Plant Blindness Intensity Throughout the School and University Years: A Cross-Age Study

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10.1 Introduction

In the mid-1980s, James Wandersee (1986) recorded for the first time in the literature a phenomenon according to which people show more interest in animals than plants. Since then, he and other researchers (Bebbington, 2005; Fančovičová & Prokop, 2011; Schussler & Olzak, 2008) have identified the phenomenon known as 'Plant Blindness', which mainly refers to: (a) the inability of humans to see, notice or focus their attention to plants in their daily life, (b) the inability to recognize the importance of plants' aesthetics and the uniqueness of their biological characteristics, (c) the tendency of humans to classify plants as inferior to animals and (d) the lack of basic knowledge regarding plant organisms (Amprazis et al., 2019; Strgar, 2007; Wandersee & Schussler, 2001). The phenomenon seems to have social and environmental impacts, as links to sustainable development are documented (Amprazis & Papadopoulou, 2020; Thomas et al., 2022). It is noteworthy that lately some researchers have questioned the validity of plant blindness as a 'whole world phenomenon' (Balding & Williams, 2016). This notion is based upon the fact that the vast majority of plant blindness research derives from the Western world, as well as upon some ethnobotany studies which outline how indigenous communities can be closer to flora than social groups in Western civilisation (Katz, 1989).

Regarding the causes of the phenomenon, the first researchers focused on the lack of intense plant movement, the types of animal activities (feeding, communication) and the external, morphological relevance of mammals to the human species (Hoekstra, 2000). Additionally, the human brain processes only a portion of the millions of information units (bits) that are continuously being sent from the eyes (Wandersee & Schussler, 2001). Plants as a common part of the visual background

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and without visible movement are not usually contained in the information that the brain chooses to process. The phenomenon appears to be even more complex and intricate, as there is a kind of 'zoocentrism' in the school context. Hershey (1996) was the researcher who first referred to this 'zoo-centric approach' in school curriculum. This notion was reinforced by later research, which recorded more visual or written references to animals than to plants in textbooks (Link-Perez et al., 2009). Regarding school teachers, they also seem to contribute to zoocentrism when, for example, they want to elaborate upon the concept of life. Here, they are more likely to refer to an animal than a plant (Hershey, 2005).

Regarding the restriction of plant blindness, in the literature one can find research mainly in the educational context. Several researchers report that specifically designed educational interventions can stimulate students' interest in plants and contribute to the phenomenon's restriction. Fančovičová and Prokop (2011) implemented and evaluated educational projects in Slovakia, involving pupils aged 10–11 years old. The children visited areas with rich vegetation and the researchers recorded a statistically significant improvement in pupils' attitudes towards plants after the educational activities. Similarly, in Lindemann-Matthies' (2005) research, students from 146 secondary schools in Switzerland increased their interest in non-common plant species through contact and guided observation of plants. Educational activities outside of school were also chosen by Borsos (2019) to enhance students' interest towards plants. Based on the results of her research, the children who participated in the study significantly improved their relative knowledge. Çìl (2016) evaluated an intervention to enhance knowledge and interest in plant organisms, which was based on the integration of elements of visual arts and chemistry in the botany lesson. According to the results, 25 children aged 10 to 12 years old improved their attitudes towards plants as they became more aware of the importance of plant organisms and increased their interest in them. In Stagg and Verde's (2018) interdisciplinary approach, English primary school pupils attended or participated in an interactive drama performance that aimed to teach basic, plant-based functions. Afterwards, an increase in knowledge and an improvement of children's attitudes towards plants was recorded. Kissi and Dreesmann's (2018) study implemented an educational intervention in a botanical garden using mobile phones. Children were involved in the whole process by observing and collecting information about different plant species in the botanical garden. This led to improved knowledge and more positive attitudes towards plants.

In consideration of all that has been mentioned above, the research questions we address here are as follows:

1. How does the intensity of plant blindness change as students move from primary school to university?
2. How does the correlation between the core elements of the phenomenon alter as students move from primary school to university?

10.2 Research Design and Method

Data were collected from 1237 students from primary school, junior high school, senior high school and university. More specifically, these were 333 students from the sixth grade of primary school, 301 from the third grade of junior high school, 305 from the third grade of senior high school and 298 from the fourth year of university. Regarding the latter participant group, they were students from primary education pedagogical departments of Greek universities. This choice was made for students from such departments who have a broader knowledge, similar to those of the general population, without having expertise in plants or any other particular field. Moreover, they are potentially compulsory education teachers who will later be called upon to teach and act as role models for the children. It has to be mentioned that only graduates from each school level were selected, in order for the participants to reflect all the background knowledge offered by every educational grade. Since primary school in Greece lasts 6 years, junior and senior high school last 3 years each, and pedagogical departments in tertiary education last 4 years, participants age range was 12, 15, 18 and 22 years old accordingly.

As there were different age groups, a cross-sectional study was chosen (Abdolmohammadi & Reeves, 2000). In general, cross-sectional studies are widely used in the field of education to examine students' attitudes and learning patterns (Prochaska et al., 2003).

The research instrument was a questionnaire. Participants' attitudes towards plants and animals were assessed through five-point Likert-type scale questions. The same type of questions was also used to assess the amount of knowledge about plants that is being offered to students in school. For example, 'how often do your teachers talk about plants?' In order to evaluate students' knowledge about flora, 'right or wrong' questions were used. More specifically, students were given specific statements and asked to rate them as right, wrong, or to admit that they could not give an opinion on the sentence correctness. Examples of such statements for primary school were 'There are plants that can grow without a root' and 'Plants make their own food', while examples for senior high school were 'Plants participate directly or indirectly in the production of all food consumed by humans' and 'All plants contain phloem and xylem to move nutrients'.

The content of these statements was determined by the knowledge offered at each school level, as this is formed by the official curriculum. During the analysis, students' wrong answers and the 'I don't know' option were consolidated and classified as lack of knowledge. The instrument also consisted of a particular question in which students were asked to freely complete a list of five living things that they could think of. That was included in order to examine participants' spontaneous recall of plants as living things (Anderson et al., 2002). Finally, a question was included in which students had to distinguish and mark out plant-derived products among 12 common daily products. To construct the research instrument, specific steps were followed, as these are determined by the literature of quantitative methodology (Creswell, 2012; Little, 2013; Teo, 2013). Initially, the primary school questionnaire was created and afterwards it was adapted to the other age groups. After determining the theoretical framework, several exploratory semi-structured interviews were conducted with students to gain insight into their conceptions and make a first assessment of the existence of plant blindness aspects. The first version of the research instrument was created and assessed by in-service teachers and students regarding its comprehension. New versions of the research instrument were created and tested through three pilot implementations (Krosnick et al., 2018). The evaluation of the questionnaire's validity was established by a group of experts in biology education and, regarding the internal consistency, the value of Cronbach's Alpha was above 0.8 for every age group. It is also important to note that by following the methodology of cross-sectional studies, wording changes were applied to the instrument in order to reflect the participants' age at each level.

In the research instrument there were six factors of the questionnaire to reflect the core elements of the definition of plant blindness. These factors were (a) Interest in plants, (b) Interest in animals, (c) Assessment of students' knowledge about plants, (d) Identification of plant-derived products, (e) Recall of plants as living things and (f) Amount of knowledge about plants offered by school.

The Spearman's rank correlation coefficient test was conducted to examine correlations between these factors. To graphically present these correlations, and hence the relationships between the phenomenon's core elements, a network analysis was also conducted (Borgatti et al., 2009). Only the statistically significant positive correlations were used for the network analysis. In order to classify the statistically significant positive correlations between the factors in the questionnaire as strong or weak, the following scale was used: .00–.19 'very weak', .20–.39 'weak', .40–.59 'moderate', .60–.79 'strong' and .80–1.0 'very strong' (Moore, 2004). To illustrate the results of the Spearman's test, the open-source software called Gephi (Bastian et al., 2009) was used. Gephi generated specific diagrams in which the width of the lines represents the level of positive correlation between the factors – the wider the line, the stronger the correlation.

10.3 Results

A Wilcoxon signed-ranks test was conducted and indicated that students' scores regarding preference for animals were statistically significantly higher than their scores regarding preference for plants, $Z = -32.51$, $p < .000$. The effect size of this statistical test was found to be large, $r = .86$. The same test was conducted for each grade individually and produced the same result every time.

A Kruskal-Wallis H test was conducted to clarify whether there is a statistically significant difference in the 'Preference in Flora' factor among the four school level groups of our participants (Table 10.1). The test was significant [$X^2(3, n = 1248) = 95.69$, $p < .05$] and follow-up Mann-Whitney U tests indicated that the high school students recorded the most negative answers regarding preference for flora. No difference was recorded among primary school and university students.

Table 10.1 Kruskal-Wallis H test results regarding students' level of schooling effect on their preference for plants (N = 1248)

Students grade	N	Mean ranks	Mean	x^2	df	Asymp. sig
Primary school (12 years old)	333	3.35	731	95.697	3	.000
Junior high school (15 years old)	301	2.99	553.2			
Senior high school (18 years old)	305	2.94	540			
University (22 years old)	298	3.42	767.8			

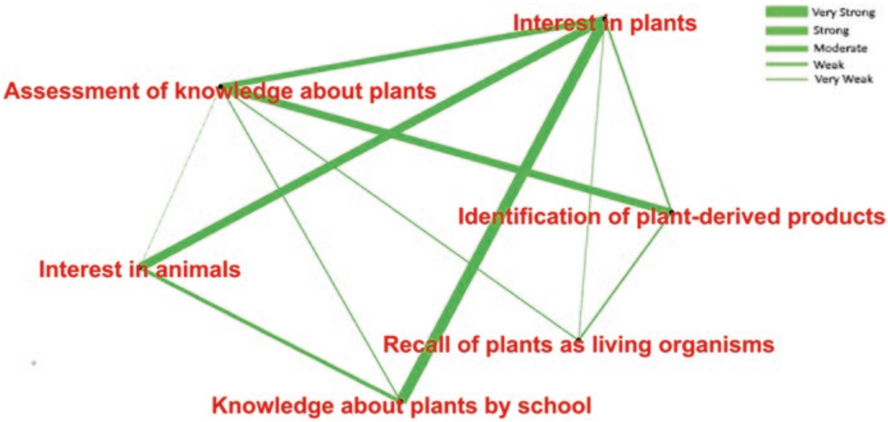

Fig. 10.1 Plant blindness' core elements' network analysis for primary school students

Different correlations have been recorded for each grade by conducting the Spearman's rank correlation coefficient tests. As shown by the follow-up network analysis, in primary school all of the phenomenon's core elements appear to be interconnected (Fig. 10.1). More specifically, regarding strong or moderate correlations, wide lines connect interest in plants to (a) interest in animals, (b) knowledge about plants and (c) assessment of knowledge about plants. Another strong correlation that is recorded is between assessment of knowledge about plants and identifications of plant-derived products. It is interesting that the strong correlations that have been recorded in primary school were also recorded in the junior high school (Fig. 10.2). By examining the correlations recorded in Fig. 10.2, one can conclude that the more junior high school students are interested in animals, the more they are interested in plants. Respectively, the more they are interested in plants, the more knowledge they have about plants. Regarding the latter correlation (interest in plants – knowledge about plants offered by school), as we move to senior high school, it is not so strong anymore (Fig. 10.3). The same applies to the correlation between interest in plants and assessment of knowledge about plants. On the contrary, the correlation between interest in plants and interest in animals remains strong, as the more senior high school students are interested in animals, the more they are interested in plants and vice versa.

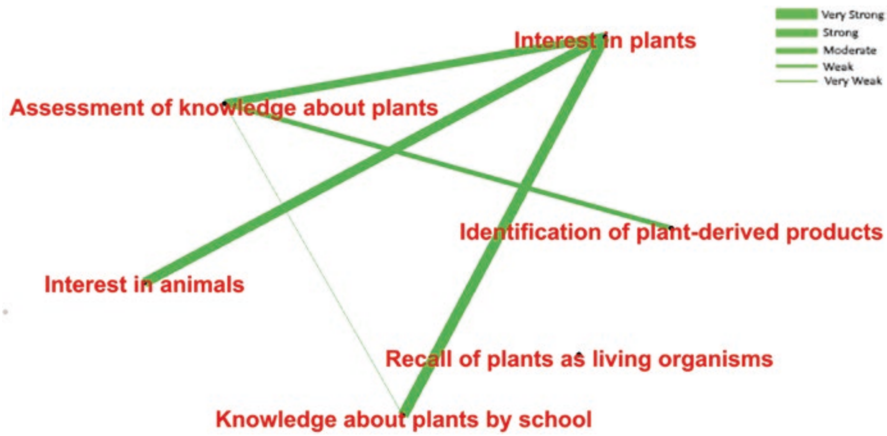

Fig. 10.2 Plant blindness' core elements' network analysis for junior high school students

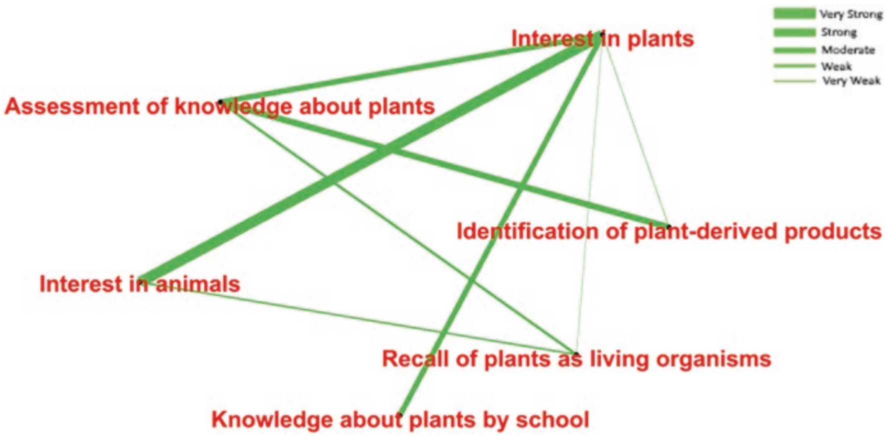

Fig. 10.3 Plant blindness' core elements' network analysis for senior high school students

Finally, by examining the network analysis of the university group (Fig. 10.4), one can draw interesting conclusions. Firstly, an all-pervasive lack of statistically significant positive correlations is recorded. Plant blindness core elements do not seem to be so connected when the phenomenon is examined among university students. The only strong correlation that one can identify is between interest in plants and knowledge about plants. Interest in plants and interest in animals are still connected, but not so intensely anymore.

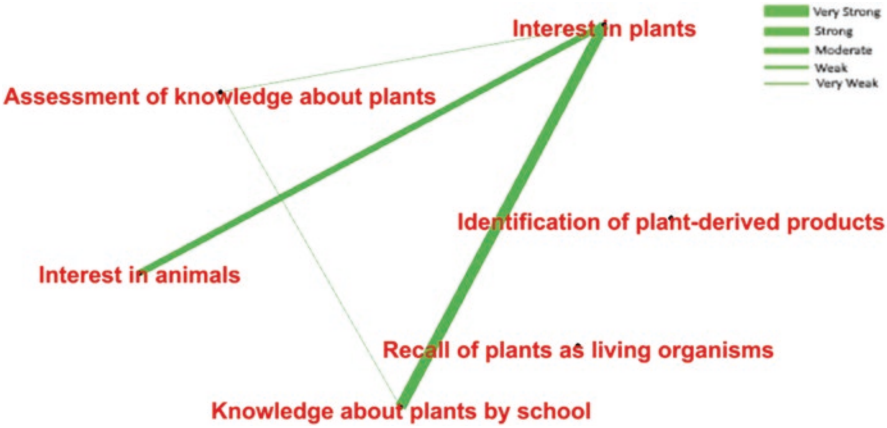

Fig. 10.4 Plant blindness' core elements' network analysis for university students

10.4 Discussion and Conclusions

Plant blindness seems to be a complex phenomenon that should be examined with caution. It is a multidimensional issue which can be incorporated, but cannot be described in its totality by just the concept of 'humans' interaction with plants. Moreover, plant blindness is an important challenge that the academic and educational community must face, especially because of its link to sustainable development. This link confirms emphatically the need for connectedness to nature as a prerequisite to achieve sustainability (Jordan & Kristjánsson, 2017).

The main conclusion regarding the cross-sectional approach is that plant blindness seems to intensify as students grow older and move from primary to secondary and higher education. Elaborating more upon this finding, one can interpret it by taking adolescence into consideration: This is a period during which people rarely show interest in issues such as the environment, as they focus more on themselves (Prochaska et al., 2003).

The alterations that have been recorded during the network analysis of each age group in this research bring to the limelight the need for a different didactic approach in each educational grade. Inside a holistic and inclusive context as educators, we may have to be flexible and adjust the educational interventions to the distinctive characteristics of each school level. Regarding primary school, the strong positive correlation that has been recorded between interest in plants and interest in animals possibly integrates the whole plant blindness issue into the biodiversity awareness context. By promoting an educational approach of fostering all living organisms on earth, human's appreciation for flora can be a collateral benefit. Moreover, the strong positive correlation between interest in plants and knowledge about plants offered by school is an indication that this cognitive background should remain solid, if not be enhanced even more. This enhancement can be achieved through a wide perspective that, besides botany, will also highlight the importance of plants for human welfare and the life phenomenon in general. Regarding junior high school, the main strong correlations remained mostly the same as in primary school. Therefore, learning about the entire life spectrum's importance and enhancing plants' meaningful and sufficient presence in the curriculum, are once again recommended Moving to senior high school, the aspect of knowledge seems to withdraw a bit, and the only strong correlation recorded is between interest in plants and interest in animals As we now have to do with older students, the biodiversity education in this grade can be based more on transformative learning and critical thinking, since the goal is to provide students with a new positive perspective of all other living components of the ecosystem. Finally, regarding university students, knowledge seems to be the most important factor correlated to their interest in flora. Consequently, provision of a comprehensive and a specialised amount of plant knowledge probably creates a framework in which fostering plant awareness can be achieved more easily. Once again, it is important to have a broad perspective and use a cross-thematic approach beyond botany that will clarify plants' relation to human culture, history, economy, and even great social endeavours, such as sustainable development.

All the educational implications mentioned above can also be integrated in environmental education and education for sustainable development. These frameworks are highly appreciated for being able to alter students' attitudes and enhance children's appreciation of the natural environment. Environmental education can promote a comprehensive approach to the living world and enable the improvement of human's relationship with animals and plants. The way environmental education projects are organised and implemented provides multiple opportunities for experiential learning, interdisciplinarity and observation of plant and animal species. In addition, the long duration and scope of these projects within a school year allows for a deeper understanding of the developmental timelines, biological functions and aesthetic properties of plants. Accordingly, it is highly recommended that educators take advantage of school gardens and botanical gardens, which are immersive educational contexts that can maximise quantitative and qualitative contact with plant organisms. They can be used consistently throughout the school year in order to enhance people's interest in flora.

Concerning limitations, the educational implications for the university students' group should be examined with caution and cannot be generalised. The choice made to include students from pedagogical departments was exactly for the purpose of being able to simulate the characteristics of the general population, at least to a certain extent. However, the relative conclusions should be limited only to preservice teachers and be assessed in relation to every educational department's course of study. Additionally, as mentioned in the methodology section of this contribution, convenience sampling was used during participants' selection to allow supervision of data collection. This can be considered as another limitation, for plant blindness is a phenomenon linked to the natural environment in which individuals live. Social groups of different geographical areas have distinctive habits and practices regarding their contact with plants and the contribution of plant organisms in meeting their daily needs. Thus, a study covering more geographical areas of the country (e.g. islands) could allow for a more reliable generalisation of the results.

As already mentioned, cultural diversity is important when one endeavours to provide a critical reflection of plant blindness; here lies a great and exciting challenge for researchers that focus on that subject. Examining the phenomenon in indigenous communities or countries that rely heavily on agriculture may lead to interesting conclusions. Research is also needed for the collection of data regarding plant blindness in age groups above 22 years old. For the most part, in the literature one can find data only about school and university students and, therefore, we do not have a clear picture of other age groups. In total, all the above future research directions can enrich the relevant literature and restrict the intensity of plant blindness even more over the forthcoming years. This is a goal that should be a priority for both developed and developing countries and may be integrated in the sustainability context.

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