

Article

Educational Activities in the Ljubljana University Botanic Gardens

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Abstract: Botanic gardens have an important role in educating people about plants. Direct contact with plants has a positive effect on the perception and understanding of plants and prevents plant blindness. In botanic gardens, pupils can learn about plants through practical work. At the Ljubljana University Botanic Gardens, educational programmes for schools have existed since 1986. Every year the Ljubljana University Botanic Gardens is visited by many different groups, from the youngest to oldest (kindergarten, primary school, graduate and professional school students, and faculties). We run around 350 guided tours for groups per year. Groups can choose either a guided tour with work sheets and workshops or they can visit the botanic gardens on their own. Most of groups are children from primary school. Ljubljana University Botanic Gardens offers programmes related to the valid school curriculum in Slovenia. Our programmes include guided tours based on level of pupils and/or practical work. The most popular time to visit is spring. But, we still have visitors in winter due to our tropical greenhouse. The most popular programme at our botanic gardens is the general tour. With our pedagogical programmes we contribute to plant knowledge, since we teach our pupils about nature.

Keywords: biology; curriculum; education; guided tours; plants



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1. Introduction

The beginnings of botanic gardens as places of learning can be traced back to the garden of the ancient Lyceum, where Aristotle first held discussions with his students during a morning walk through the garden, followed by public lectures on plants later in the day [1]. Theophrastus also saw gardens as places for the study and close observation of plant species, with particular emphasis on the study of useful plant species, both native and foreign, and the study of their adaptation to new habitats [2]. It is, therefore, a mission that botanic gardens still carry out today. The garden in the Lyceum was actually the first garden that could be said to be the basis for the so-called “modern” botanic gardens around the world [3]. During the upsurge of Christianity, knowledge about plants was concentrated mostly in monastery gardens, where they mainly study the medicinal properties of plants. Monasteries were once treasure troves of knowledge, with monks having roles as spiritual and secular teachers as well as healers. Gardens with plants served as a source of material for medicines. Herbs, cultivated plants and other useful or poisonous plants were planted in these gardens. In the past, medical knowledge also included herbalism, since plants were the main source of medicinal substances. Physicians had to clearly distinguish a medicinal plant from a poisonous one, and ascertain which parts of the plant could be used as medicine. From the point of view of the shape and organisation of the garden, monastery gardens were the predecessors of today’s botanic gardens, which developed from medical educational gardens in Italy at the end of the 16th and the beginning of the 17th century. Some of the first established botanic gardens were in Pisa (1543), Padua (1545) and Florence (1545) [4–6]. In terms of their content and operation, they again came close to

the original Lyceum garden [3]. Today's botanic gardens are centres of knowledge, research and botanical science.

Founded in 1987, Botanic Gardens Conservation International (BGCI) has always emphasised the role and goals of botanic gardens in relation to education. Education about the environment and plants should be one of the main roles of botanic gardens. Many botanic gardens already incorporate sensory, active, cooperative and empathic approaches to educating about plants, with the aim of fostering understanding and respect for the natural world. As themes, BGCI suggests the connection between plants and water, ethnobotany, biodiversity, the importance of plants for humanity, tourism, habitats and edible plants [7]. Since 1991, BGCI has also been organising an international congress on education within botanic gardens. It takes place every three to four years. The congress is intended for researchers, teachers, curators, academics and experts who present innovations, advantages, disadvantages and ideas in connection with education within botanic gardens [8].

A survey of over 120 respondents found that as many as 91% of botanic gardens include education in their vision and emphasise its important function, while approximately 25% of botanic gardens do not have established funding for education [9]. A study by Tampoukou et al. [10] showed that teachers highlight botanic gardens as the most important place for educating about environmental topics. The botanic garden was highlighted as the most suitable green area for the implementation of such programmes, especially for primary schools. They also emphasised that botanic gardens must provide adequate infrastructure for teaching, namely open space, places suitable for gatherings of a number of people, easy access, different types of ecosystems and indoor spaces for schools. The study showed that 72.7% of teachers knew about botanic gardens, but only 34.5% visited them. But, botanic gardens are places where students can come into contact with nature safely and under controlled conditions. When teaching biology, teachers must bring nature closer to students, as most of them have already lost contact with nature. It is very important that children have positive contact with nature and plants from an early age, as this is crucial for developing their attitude towards nature in adulthood [11]. Environmental education, which students undertake in the natural environment, is more effective than education in the classroom. Differences appear in students' emotions, actions and cognitive thinking. But, better educational results have been achieved with the involvement of botanic gardens. In this scenario, the students had fewer negative emotions, better environmental awareness and a desire to take actions that would not harm natural processes. They also developed a greater desire to live in harmony with nature [12]. Studies have shown that it is important for children to learn about plant species, habitats, the role of plants in people's lives and their value in general. Children should be motivated to grow plants and to determine between different plants, thereby improving their understanding of the importance of plants [13]. It has also been proven that students who have touched plants, and thus learned about them more closely, had a better attitude towards plants and experienced them as being more interesting [14].

The Ljubljana University Botanic Gardens have had an educational function since their very beginning, and were in fact founded with the aim of providing assistance in the teaching of natural sciences. The main initiator of their founding and, at the same time, their founder was Franc Hladnik, a teacher at the Central Schools. During the time of the Illyrian Provinces, as evident from archival documents and records [15–20], he became a professor of natural science and botany at several tertiary education schools. The French education here, after many attempts by the revolutionary governments, was based on the order of the National Convention from 1795 and operated through the establishment of Central Schools, in which all sciences and arts were to be taught. A botanic garden [17] was a required component, and so the Ljubljana University Botanic Gardens were therefore founded in 1810 on Hladnik's initiative. Later, even after the abolition of the Central Schools and until 1834, Hladnik gave high-profile botanical lectures. Offering botanical lectures as an elective course was an advantage of the educational programme in Ljubljana compared to education in other provinces and cities where such courses were not provided [18,21]. After Hladnik,

physician Janez Nepomuk Biatzovsky (1801–1863), who came to Ljubljana as a professor of physics, chemistry and botany at the medical and surgical school in 1833, took over the botanic gardens and continued giving botanical lectures at the gymnasium [22]. After his departure to Salzburg, Andrej Fleischmann, who was a young gardener during Hladnik's time, took over the gardens. In addition to continuing to teach botany as a preparatory course and in the agricultural school, Fleischmann also taught fruit cultivation, which at that time took on a very important role. He also took over providing botanical lectures at the gymnasium, which were considered an elective course and were introduced by Hladnik himself. Fleischmann greatly popularised the gardens in his time. The University Ljubljana Gardens were accessible to the public in the afternoon. [22]. In 1849, he wrote about the importance of natural science, which he tried to introduce to the general public [23]. He emphasised that botany should be taught in schools from the earliest years. In particular, he encouraged those writing textbooks not to forget about natural sciences. Every Wednesday, from 5 to 6 pm, he held botanical lectures in the botanic gardens, because, as he wrote, "True knowledge of plants cannot be achieved from books and painted images, but where the plants grow" [23]. In 1851, he was already holding lectures that were open to the general public in the gardens, and the lectures were free. In addition to botany in the strictest sense, Fleischmann was also working in the field of applied botany, particularly fruit cultivation. He helped farmers throughout Carniola with advice and participated in agricultural exhibitions [23].

Alfonz Paulin again greatly strengthened the research activity of the Ljubljana Botanic Gardens. He worked in the gardens for 45 years (from 1886 to 1931) [24]. Until the founding of the University of Ljubljana in 1919, the botanic gardens operated under the secondary school, but came under the restored University of Ljubljana in 1920. As early as 1912 [25], the gardens were so well organised that they could compete with many important university botanic gardens across the world. That year, the gardens had 6000 species and contained almost all the species represented in the Carniolan flora. Paulin was involved in the arrangement of several private and school gardens as a consultant and supporter [26]. At the university, he lectured part-time on systematic botany and led plant identification exercises. Paulin was an exemplary professor and tried to teach students to observe nature as accurately and in as much detail as possible [23]. It was for this purpose that he wrote the first Slovenian original textbook for teaching botany in the lower grades of gymnasium, which was published in 1898 [27,28]. His successor, Prof Dr Fran Jesenko, took over the management of the gardens after Paulin and was also a university teacher in botany at the University of Ljubljana [27]. After him, the management of the gardens was also taken over by university professors. Dr Gabrijel Tomažič, an assistant and then an assistant professor and associate professor of botany at the University of Ljubljana, managed the gardens during the Great war period [29]. Botany lectures were continued after the war by assistant professor Dr Tomažič, and the management of the Botanic Gardens was taken over in 1946 by his assistant Dr Jože Lazar, who led it until 1967. Later, he held lectures on the systematics of lower plants at the University of Ljubljana [27,30].

In 1967, the management of the gardens was taken over by Prof Dr Vinko Strgar (1928–1992) [31] who was an associate professor of taxonomy and flowering plant cultivation. He taught botany at the Secondary School of Pharmacy and collaborated on the subject of *horticulture* at the Department of Agronomy of the Biotechnical Faculty. He also lectured at the Pedagogical Academy on the subject of the *culture of living space*, with an emphasis on learning about plants, horticulture and school gardens. Strgar also advocated for the popularisation of botany; consequently, he often published various articles in the Slovenian popular science magazine *Proteus* [32], specifically in the *School Garden* section [33]. He discussed various topics suitable for school gardens [34–37].

Since 1995, when one of the authors took over the management of the gardens, the educational role of the Ljubljana University Botanic Gardens has increased significantly. Thematic tours for schools are organised for all educational levels [38,39]. Guided tours with a specific plant theme and practical workshops are also aligned with the national

curriculum [38]. During tours, students also receive worksheets. We also help some high and higher schools to conduct practical lessons for students. During internships in the Botanic Gardens, they learn the basics of gardening and horticulture, identifying plant species and their ecology [40]. In addition to Slovenian pupils and students, foreign students also carry out internships in the Botanic Gardens. And, of course, the Botanic Gardens are a key teaching aid in learning botany for biology students of the Biotechnical Faculty, which the gardens are a part of [39,41]. The employees of the Botanic Gardens are also holders of degrees in *applied botany and the in situ and ex situ protection of plant species* at the second level of study of *ecology and biodiversity* at the Biotechnical Faculty, as well as holders of the degrees in the *ex situ protection of plant species* from the Faculty of Natural Sciences and Mathematics of the University of Maribor. As a collection of plants with a known origin and proven determination, the Ljubljana University Botanic Gardens are also an institution that represents a source of plant material for research and, of course, for research projects, diplomas and doctoral theses. At the same time, the Botanic Gardens are still actively involved in consulting on and arranging school gardens and preschool gardens. Furthermore, the Botanic Gardens promote so-called citizen science, raising general public awareness of plants and their significance via public lectures, workshops, exhibitions and involvement in green infrastructure projects [42]. As a BGCI-certified botanic garden, the Ljubljana University Botanic Gardens also follow the guidelines and action plans for EU botanical gardens [43] at all times.

Because of the long tradition of teaching about the plant world at the Ljubljana University Botanic Gardens, we conducted an analysis as part of our study of visits from school groups over the last ten-year period. We were mainly interested in how the number of students on guided tours has changed and which of the tour topics were the most common. Considering the trend of the increased popularisation of plants and their importance among the public, we were interested whether topics related to the protection of nature and the importance of the relationship between plants and pollinators have become more popular in recent years. We also examined the extent to which the range of subjects in the Ljubljana University Botanic Gardens is aligned with the national curriculum and the guidelines regarding education proposed by the Botanic Gardens Conservation International. The findings will provide a better insight into the wishes of teachers, which plant topics are trending and which of the topics should be further popularised. The results could be used to help with further planning of education in our botanic gardens and also in other botanic gardens.

2. Materials and Methods

2.1. Ljubljana University Botanic Gardens

The Ljubljana University Botanic Gardens are located in the centre of Ljubljana, Slovenia. The gardens cover an area of two hectares. The gardens are divided into several substantive units, which are also marked on the garden map (Figure 1). A seed bank has been operating inside the gardens since 2016. The gardens are open every day of the year. Entry to the outdoor part of the gardens is free, as is entry to one of the glasshouses. An entry fee is only required for the tropical glasshouse.

Education at the gardens is carried out in several ways. The gardens provide education indirectly with the help of various educational information tables and marking signs for plant species. Because these areas of the Botanic Gardens are freely accessible, this method of education is accessible to everyone free of charge. Direct education in the gardens themselves takes place in the form of guided tours, various public lectures and participation in various events. In addition to guided tours, we also organise public guided tours and workshops, which are not included in the analysis of this article. Eleven people are employed in the gardens, of which two are university teachers and two have a pedagogic education, actively working in the field of guided tour education. During periods of high demand for guided tours, biology and pedagogy students and volunteers also help with the guided tours.



Figure 1. Map of the Ljubljana University Botanic Gardens.

2.2. Analysis of Guided Tours in the Ljubljana University Botanic Gardens

The Botanic Gardens have been keeping records of guided tours for many years. We reviewed records from 1986 to 2023. We counted the number of people participating in guided tours. We also analysed the records for a 10-year period in more detail, specifically the period from 2013 to 2023. We counted the number of guided groups, which gave us an insight into the tours over a period of ten years. One group is defined as a group of persons led by one guide. The number of people in the group may vary depending on the age of the participants. With younger children, the number of persons in the group is smaller than with older children or adults. As already mentioned, the Botanic Gardens are visited by groups of different ages. We offer several different programme topics for visitors. Because our topics are quite diverse and because we offer different topics for individual periods that are adjusted according to age (more information about the programmes can be found at <http://www.botanicni-vrt.si/strokovna-vodstva>, (accessed on 5 August 2024), we first classified the programmes into 13 of sets (1—General tour; 2—Plant organs; 3—Ecology; 4—Systematics; 5—Pond, marshes; 6—Independent work; 7—Plants and pollinators; 8—Woody plants; 9—Reproduction and propagation of plants and flowers; 10—Medicinal and useful plants; 11—Heralds of spring; 12—Biodiversity; 13—Planting). We reviewed our records of guided tours and determined which topics were selected at which times. Some groups chose several different programmes at the same time.

2.3. Analysis of Curricula

To determine the connection between the topics within our guided tours and the curricula in Slovenia, we first reviewed the learning objectives for all grades of primary school (1st to 3rd grade: Environmental education; 4th to 5th grade: Natural science and technology; 6th to 7th grade: Natural science; 8th to 9th grade: Biology) and high school (high school and gymnasium: Biology) [44,45] (Supplementary Materials). We counted the number of learning objectives covered by each topic within the guided tour and determined which programme covers the most learning objectives. We have shown the coverage of objectives using graphs.

2.4. Statistical Analysis

Statistical analyses and various graphs were prepared using Microsoft Excel 2010.

3. Results

3.1. Number of People Participating in Guided Tours

Figure 2 shows the number of participants in guided tours. The highest number of people participated in guided tours in 2016 (8957 persons), and the least in 1993 (111 persons). Over the years since the beginning of the study period, there has been an increase in the number of visitors (especially since 1995, when we introduced another method of guided tours). After 2000, the number of persons remains fairly constant with occasional fluctuations. The largest decrease can be observed during the SARS-CoV-2 (COVID-19) pandemic.

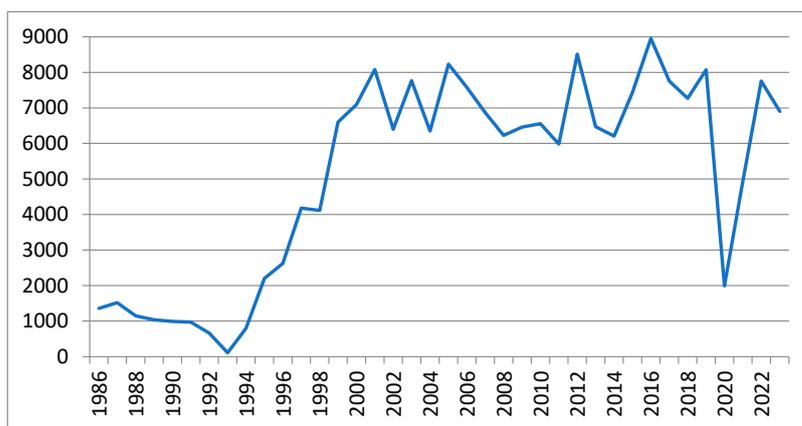


Figure 2. Number of participants in guided tours in the period from 1986 to 2023: average number of visitors (1986–1993: 974; 1994–2001: 4461; 2002–2019: 7171; COVID-19 period: 3470; 2022–2023: 6534).

3.2. Number of Groups on Guided Tours

In the Ljubljana University Botanic Gardens, visitor groups vary in size, but are almost never larger than 30 people. For preschool and school groups, we try to keep the sections and groups to a single preschool/school, but if the sections are large, we divide them in half. The standard group size is approximately 25 persons. Figure 3 shows the number of groups over a period of 10 years. The most groups visited the gardens in 2019.

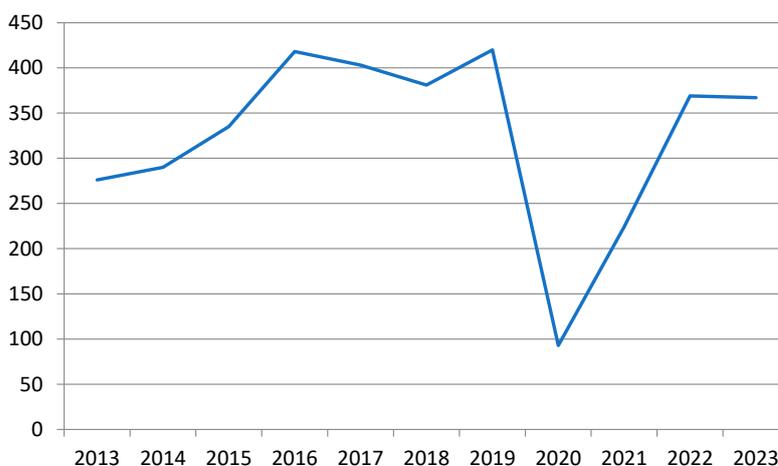


Figure 3. Number of groups on guided tours in the period from 2013 to 2023.

3.2.1. The Ratio of Groups Participating in Guided Tours by Age Group

Below is an analysis of the number of guided tours carried out over the ten-year period by age group (Figure 4): most tours were attended by primary school children (61.82%),

and the least by preschool children (3.72%). The second most frequent visitors were high school students (21.27%), followed by adults (10.31%) with half as many visitors, and then faculties and universities (3.72%).

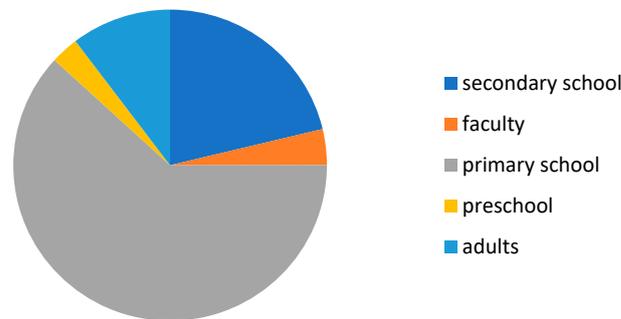


Figure 4. Overview of different age groups in the period from 2013 to 2023.

3.2.2. Number of Guided Tour Groups by Month

The highest number of groups appear to take part in guided tours between May and June (Figure 5). In general, attendance is higher in spring and autumn, while the number of groups decreases during summer and winter. The trend lines mostly show the same phenomenon over the years. A change was observed in 2020; specifically, there were no guided tours in the spring due to the SARS-CoV-2 (COVID-19) outbreak. In the autumn of this year, the trend line shows an increase, which is due to the suspension of restrictions on the operation of public institutions during the epidemic. In recent years (from 2018 onwards), excluding 2020, there has also been an increase in the number of guided tour groups in November.

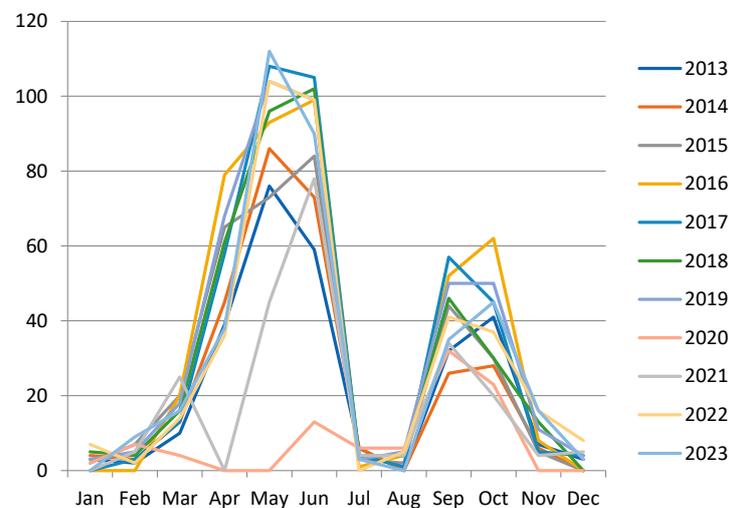


Figure 5. Number of groups in the period from 2013 to 2023 by month.

3.2.3. The Most Frequently Selected Programmes on Guided Tours

The most frequently chosen programme in the ten-year period (Figure 6) is a general tour of the gardens. The general tour of the gardens includes a tour of the glasshouses and the outdoor part of the gardens. During the general tour, we show the attractions within the garden and also provide a brief history of the gardens. For groups with older participants, we also show our seed bank. The second most frequently chosen topic is “plant organs”. This topic is often chosen by groups (mainly those in the sixth grade of primary school) as it repeats sixth-grade material in combination with practical work—the observation of preparations under a microscope. On the garden tour, they see all parts of the gardens, where we present them with different plant organs and their transformations. Another frequently chosen programme is the Reproduction and propagation of plants, where we

talk about asexual and sexual reproduction. Other popular programmes also include topics such as “pond and marsh flora”, “medicinal and useful plants”, and “planting”. The least frequently chosen topic is “biodiversity”, in which we present our endemic, endangered and native species to visitors, and also discuss the issue of invasive species.

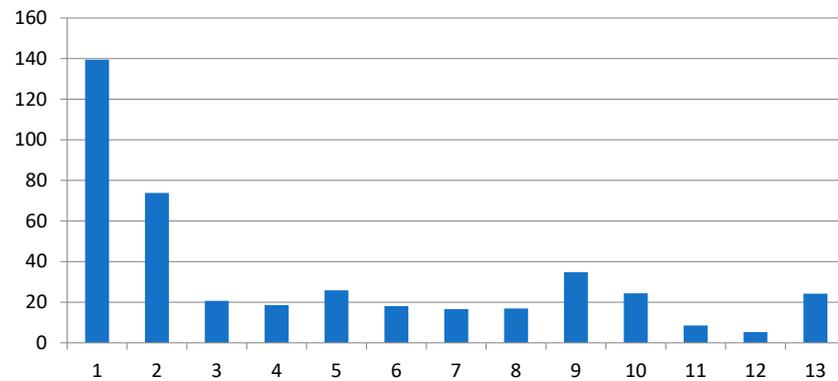


Figure 6. Average number of programme topics selected in the period from 2013 to 2023 (1—general tour; 2—plant organs; 3—ecology; 4—systematics; 5—pond, marshes; 6—independent work; 7—plants and pollinators; 8—woody plants; 9—reproduction and propagation of plants, flowers; 10—medicinal and useful plants; 11—heralds of spring; 12—biodiversity; 13—planting).

In the last two years of the study (2022 and 2023), an increase in the choice of the topic of “Planting” was observed (Figure 7). During these years, we introduced not only the transplanting/planting of plants, as was the case before, but also the planting of cuttings and demonstration of reproduction using various cuttings. We also observed an increase in the choice of topic of “Independent work”, where, after the guided tour, the participants receive a worksheet with tasks and then solve the worksheet independently by exploring the gardens. The decrease in the choice of topic of “Woody plants” in 2021 is associated with the closing of the gardens during autumn. After 2019, we also observed an increase in the choice of topic of “Plants and pollinators”, where we present, in addition to plants, our educational apiary and the life of bees and other wild pollinators.

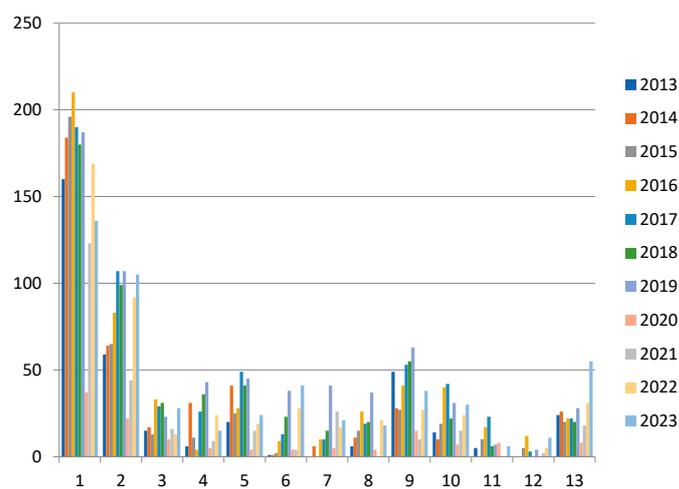


Figure 7. Chosen topic for guided tours by year in the period from 2013 to 2023 (1—general tour; 2—plant organs; 3—ecology; 4—systematics; 5—pond, marshes; 6—independent work; 7—plants and pollinators; 8—woody plants; 9—reproduction and propagation of plants, flowers; 10—medicinal and useful plants; 11—heralds of spring; 12—biodiversity; 13—planting).

3.3. Analysis of Curricula

With our programmes, we cover most of the learning objectives (Figure 8) in the sixth grade of primary school; specifically, as many as 42 are covered within the General

programme. In the sixth grade, most of the year is dedicated to learning about plants. With a guided tour of our gardens, high school students can cover 51 learning objectives, specifically by choosing the General programme or the “ecology” topic (Figure 9). The lowest number of learning objectives are covered for the eighth grade; specifically, only four objectives can be covered with the “ecology” programme (Figure 8). In the eighth grade, most biology lessons are aimed at learning about the human body, and only a small section discusses biological research in general. Figure 9 shows that the “medicinal and useful plants” topic is often chosen for eighth-grade students, since this topic can provide useful knowledge about human health. In the ninth grade, biology lessons are intended to educate students about biodiversity, systematics and coexistence with nature, so a general guided tour can cover a maximum of 17 learning objectives (Figure 8). In other classes, the coverage of the learning objectives with the guided tour is quite similar, ranging from five to seven learning objectives (Figure 8). The best choices for the first and third grades is “ecology”, “woody species” and “plant growth cycle (reproduction)”, which is also a suitable topic for the second grade. For the fourth and fifth grades, the best choice of topic is “plant organs” (Figure 9).

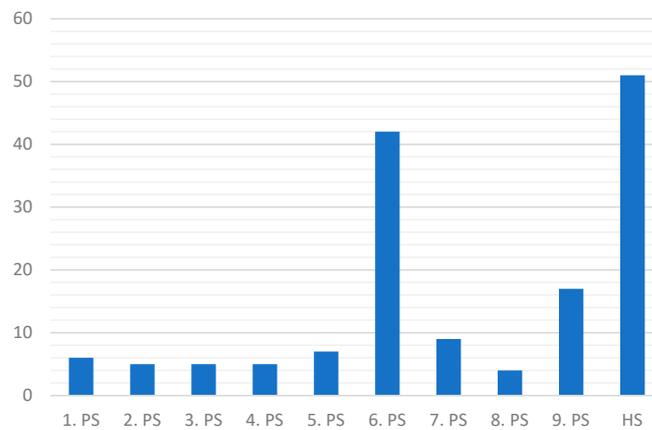


Figure 8. Maximum number of objectives covered from 1st to 9th grade of primary school (PS) and high school (HS) (the high school curriculum is flexible and does not specify precisely when a topic should be covered; therefore, in this table, the entire high school programme is combined in one column). High schools have a curriculum that is not divided by year, that is why high school is presented in one column.

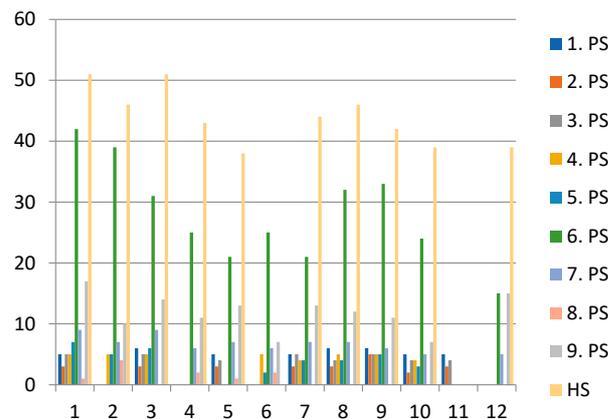


Figure 9. Number of objectives covered in the topics of guided tours by grade (PS—primary school; HS—high school) (1—General tour; 2—Plant organs; 3—Ecology; 4—Systematics; 5—Pond, marshes; 6—Independent work; 7—Plants and pollinators; 8—Woody plants; 9—Reproduction and propagation of plants, flowers; 10—Medicinal and useful plants; 11—Heralds of spring; 12—Biodiversity). High schools have a curriculum that is not divided by year, that is why high school is presented in one column.

4. Discussion

In addition to their traditional functions of scientific research and education, botanic gardens now also have the functions of protecting plant species, tourism and green infrastructure. They certainly have many other functions and are as institutions that are intensively involved in public life. For these reasons, we would expect them to be recognised in the educational system as one of the main educators on the plant world using their living plant collections. Unfortunately, this is not the case. Both the field of botany and botanic gardens are still often ignored by scientists and the public. The primary reason for this is a common phenomenon among people called “plant blindness”—a concept introduced by Wandersee et al. [46]. Plant blindness refers to the inability to notice or see plants in one’s surroundings or to recognise their importance for the environment and humans, and the inability to appreciate the aesthetic and unique biological properties of plants. The term has also been explained by the fact that it is a habit among people to consider animals to be more important than plants. Plants with more inconspicuous flowers and more common green leaves are also less noticeable to people and therefore more difficult to notice. In the case of ruderal species, they are often described as a “weed”, which in many people evokes a negative connotation, thereby depriving the species of its ecological importance in the environment [47]. In an experiment involving 210 students, 20 objects were exhibited—75% were plants and 25% were animals. The children chose as many as 59.3% of animals and only 40.7% of plants, although the share of plants among the items that could be chosen was larger [37]. People mostly notice characteristics of plants such as colourful flowers, smell, interesting fruits and their general beauty, but often do not fully understand the importance of plants for the environment [48]. This makes the role of botanic gardens as popularisers of plants and as a connecting link between science and the public all the more important. In 2023, the BGCI stated that more than 750 million people visit botanic gardens each year. It is through education that we can present the important role of botanic gardens in solving global issues such as climate change and its connections with plant food sources and biodiversity [49].

A 2011 study found that, out of 206 botanic gardens surveyed throughout the world, more than 50% have a group of employees in charge of education in the botanic gardens. Unfortunately, in as many as 94% of botanic gardens, the number of employees in the field of education represents less than half of the total staff [50]. The situation in the Ljubljana University Botanic Gardens is also similar, as only four individuals work in the field education in the botanic gardens, in addition to working on other tasks. Furthermore, funds for salaries from the Ministry of Higher Education, Science and Innovation are only sufficient to cover the salaries of two people. Considering the above, it is clear that the importance of the educational function of botanic gardens is often not understood by either the government or the competent ministries. A survey of 120 botanic gardens reached a similar conclusion, clearly showing a lack of government funding for educational programmes in botanic gardens [9]. Nevertheless, on the other hand, more and more teachers take advantage of botanic gardens as additional opportunities for teaching about plants and nature in general [51,52].

The Ljubljana University Botanic Gardens have also been organising guided tours for educational purposes since 1986. In the first few years after 1986, the number of participants in the tours did not exceed 2000, with the first obvious decline in participants in 1992 due to the sudden death of the then head of the Botanic Gardens. At that time, the fate of the Botanic Gardens and their management was being questioned. The management of the gardens was more or less left to the gardeners. In 1995, when the oldest of the authors of this article took over the management of the gardens, the number of participants on guided tours began to rise sharply. At that time, the first targeted topics and the systematic organisation of guided tours were introduced. Also, because of the growing number of visits and the lack of employees in the University Botanic Gardens, guidance from biology students who passed a systematic botany exam was introduced. The biology student guides were previously trained by the teaching staff in the Botanic Gardens. From 2001 to

2019, fluctuations were observed in the number of participants on guided tours, primarily because of weather conditions. Although a lecture hall has been available for guided groups in case of bad weather since 2006, as well as a tropical glasshouse with 530 m² of covered areas since 2010, teachers do not opt to visit the Botanic Gardens in bad weather. The largest number of visitors taking part in guided tours was in 2016, which can be attributed to greater attendance from Ljubljana schools, as Ljubljana was the Green Capital of Europe in 2016 [41]. This made all institutions connected with nature more interesting to visitors. Of course, the biggest decline in the number of visitors on guided tours after years of minor fluctuations was observed during the SARS-CoV-2 epidemic.

Comparing the last ten years, the number of guided groups mostly followed the same trend as the number visitors taking part in guided tours. Similarly, with an increasing number of people on guided tours, the number of groups also increased. The largest share of groups is represented by groups from primary schools. The main reason is that in each three-year period of primary school, the curriculum touches on the subject of natural science. An environmental education is also included in the first three-year period, natural science and technology are included in the fourth and fifth grades, science in the sixth and seventh grades and biology in the eighth and ninth grades [44]. Thus, we offer extensive programmes aligned with the primary school curriculum in the Botanic Gardens. This means that an individual student can visit the Botanic Gardens as part of a guided tour four or more times during their education in primary school. In the high (secondary) school curriculum in Slovenia, there is somewhat less emphasis on the visible world of plants, which is reflected in the smaller number of guided groups of high school students compared to primary school students. Although the Ljubljana University Botanic Gardens offer various programme for preschool children, the share of these groups is the lowest. For this age group, we include various riddles, stories, fairy tales, and songs about plants as part of our guided tours. Within the Botanic Gardens, children can move freely (walk, feel, smell plants), and we emphasise a sensory approach using all the senses: smell, taste, touch, hearing and sight. There are also many animals in the Botanic Gardens, which children can observe and talk about with the guide. The reason why educators do not choose guided tours more often, despite the various programmes, is primarily that the responsibility and organisation of taking children on a trip outside the preschool is significantly greater than with older children. Also, guided tours can be more tiring for preschool children as they have a shorter attention span. Unfortunately, there is similarly low interest in guided tours even on the part of natural sciences faculties, which is reflected in the small number of guided tour groups for this group in the Botanic Gardens. Nowadays, the teaching of microbiology, genetics and biochemistry is emphasised in natural science education in science faculties, while the visible living world represented by plants and their relationships with the environment (plant ecology) are forgotten. Scientific studies are too disconnected from the living world, with contact with the living world not being emphasised enough. A possibility for the greater inclusion programmes of the Botanic Gardens programme in various natural science studies could be the implementation of laboratory exercises in the Botanical Garden. The Ljubljana University Botanic Gardens has 12 electronic monocular magnifying glasses and 12 microscopes and a lecture hall where such exercises can be performed. Biology students could also carry out mandatory practice in the Botanical Garden. This has not been foreseen for biology students in their educational process so far. In addition to the above, students could carry out various research work as part of their studies, using the plant collections in the Botanical Garden as a source of plant material under the mentorship of the Botanical Garden's pedagogical staff. A study by the BGCI [9] found a similar trend in the representation of educational levels among the surveyed botanic gardens. Children between the ages of 5 and 11 represented the largest share of visitors participating in guided programmes, followed by those aged 11 to 16, while the smallest share was represented by university students. In the University Botanic Gardens, we have pedagogical staff from various education levels. One is preschool teacher and biology teacher for a primary school and another a biology teacher for primary school with

experience in a high school, as well as two university professors. In our preschool tours we try to use our senses (sight, smell, touch, hearing and sometimes even taste). Which means the guide is not just talking but shows the exhibits using the senses. Guided tours for primary and secondary school students have more talking, but we still try to use our senses, since in our experience this method is useful for older pupils too. In our programmes, we try to stay close with the nature so we do not use any digital resources and mobile phones are also not allowed on our guided tours. We do not want pupils to be burdened with technology.

In terms of the times preferred by visitors to the Botanic Gardens, the springtime stands out, especially the months of May and June. While it is true that the vegetation in the Botanic Gardens is in the optimal phase of development and that it is possible to carry out guided tours on a large number of different topics, this is more a result of the organisation of lessons, which plans for various excursions at this specific time. Another such period is in September and October, although the number of guided groups is almost 50% lower than in the summer season. In September and October, classes are just getting started, which is why teachers mostly start teaching natural science theory at that time. At the same time, of course, the growing season of the plants is already at its end, and the interest in guided tours is consequently lower. By introducing programmes that could be carried out exclusively in the tropical glasshouse and as laboratory exercises in the lecture hall, we are trying to encourage teachers to organise visits to the Botanic Gardens even in late autumn and winter. However, this trend has not changed so far. Other botanic gardens in temperate climates are also most often visited in the springtime [53].

Teachers organise visits to botanic gardens for various reasons, such as connections with curricula, connections with general knowledge, the promotion of lifelong learning, increasing interest and motivation, a change of environment and teaching routine, the achievement of school expectations, increasing students' socialisation and the enjoyment of nature [52]. For children, Botanic Gardens visit should be a basic part of teaching, since children can connect with nature and learn about it directly. In the Ljubljana University Botanic Gardens, we offer 10 different programmes for both the first and second triads of primary school, while for the third triad we offer 18 different topics. For secondary schools, 15 topics are available. The lists of topics and their descriptions are explained in more detail on the Botanic Garden website. There, teachers can read about what each programme offers in advance. Before the start of each school year, we also send shortened descriptions of the programmes we offer to an online lists of schools and teachers that the Botanic Garden has in its address book. This allows teachers to plan when they will include the Botanic Garden in the curriculum when teaching natural sciences at the beginning of the school year. However, despite the rather diverse range of topics and programmes, at the Ljubljana University Botanic Gardens, for the ten years included in our study, we found that teachers most often choose a "general tour" of the Botanic Gardens, with the tour being adapted for the age group of the children and the time of year. With this topic, students learn about the Botanic Gardens, their importance and the plants that are in the optimal vegetation phase at the time of the visit. This is a topic that can be included in natural science lessons at various educational levels and is therefore popular among teachers. Compared to the other available topics, teachers often also choose the topic of "plant organs" and the topic of "reproduction and propagation of plants". Both topics are related to the sixth grade curriculum, which covers plants in more detail. The choice of other topics is similar and, of course, largely depends on the teacher and their willingness to include the plant world in natural science outside of the prescribed curriculum. At the same time, it should be noted that some topics are specifically adapted for specific age groups. While the topic "heralds of spring" is chosen mainly by the teachers of the first three grades, the topics of "systematics" and "biodiversity" are primarily chosen only for the sixth grade onwards, which is completely understandable. There are more complex topics that require adequate prior knowledge and somewhat abstract thinking, which younger children are not yet capable of. As for the choice of specific topic in specific years

of the ten-year period, we observed a slight increase in all topics until 2020, when the pandemic occurred and guided tours were not allowed. After everything “returned to normal”, the situation for the guided tours returned to somewhat mimic the one before 2019, but unfortunately not yet with the same number of groups as before the pandemic. Only the topic of “planting” did not change significantly in proportion between individual years and even increased after the pandemic period. The reason for this could be the fact that the pandemic and related restrictive measures stimulated people’s desires for living plants in their homes and therefore also their interest in growing plants. It was a general phenomenon in society, which of course also spread to schools [54]. There was a desire to teach children how to plant and grow plants. As part of the “planting” topic, children, in addition to having a general tour of the Botanic Gardens, plant their own plant, learn how to take care of it, and take it home with them. In 2019, we also noticed a sharp increase in the selection of the topic “plants and pollinators”, which is a result of the designation of May 20 as World Bee Day. World Bee Day was declared in 2017, and the first celebration took place in 2018. With World Bee Day, interest in all pollinators and their connection with plants has grown, which has also been reflected in the Botanic Gardens. Although biodiversity, its importance and conservation have been increasingly discussed among the general public in recent years [55,56], this topic is the least frequently chosen by teachers in the Botanic Gardens. This is probably because the concept of biodiversity is still somewhat abstract for students and teachers usually do not put much emphasis on this subject in Slovenia, because the curriculum is already comprehensive and they do not have time for it. Anyway, we still present biodiversity somehow in all our programmes for different ages, since the topic of biodiversity is a wide concept. When preparing various pedagogical programmes at the Ljubljana University Botanic Gardens, we found that the more different programmes there are to choose from, the more teachers will be interested in visiting the botanic gardens. In general, teachers like a lot of pre-prepared programmes, allowing them to bring a single group of students on a guided tour several times during their education.

In a survey on educational programmes among 120 botanic gardens, Kneebone and Wilson [9] found that the most common programme topics in botanic gardens were plant diversity (as many as 90%), protection (84%), ethnobotany (78%), plant science (76%), endangered plants, horticulture, etc. Only a third of botanic gardens offer the topic of environmental issues, which is one of the most important current political and environmental topics these days. When reviewing websites [57–73] with topics offered for guided tours in the Botanic Gardens, we found that other botanic gardens also offer topics for children of different ages. Some botanic gardens offer only a general tour of their botanic garden, while others offer a wide range of topics. The garden that offers the most topics is the New York Botanical Garden, offering as many as 34 different topics. There are other gardens that only offer a general tour, specifically three. Others offer from two to thirty-four different topics. Topics or programmes are usually listed on botanic garden websites according to the different grades or ages of children, ranging from preschool children to university students. The most common topic listed on the pages of botanic gardens was a general tour of the gardens (this topic is offered by 10 gardens). The second most common topic was edible plants (this topic is offered by nine botanic gardens). This is followed by other topics, including a tour of the tropical glasshouse, biodiversity and ecology (all these topics are offered by seven gardens). Topics related to plant adaptations (this topic is available in six gardens), the presentation of trees, topics on flowers and topics related to the seasons are also very common (these topics are available in five botanic gardens). Gardens often also represent plants in connection with water, medicinal and useful plants, plants and climate change, human influence and plant reproduction (these topics are available in four gardens). The topics of plant microscopy, gardening, native plants, sensory presentation of plants, living fossils (three times) appear less frequently. There were also other interesting topics, such as the connection with pollinators, magical plants, poisonous plants, terrariums, plants and music, endangered plants, plant evolution, etc.

As already mentioned, in the Ljubljana University Botanic Gardens, we try to offer a wide range of educational topics to meet the learning objectives set by the Ministry of Education. Most learning objectives are achieved with our programmes for high (secondary) schools, primarily with topics like the “general tour” of the botanic gardens and “ecology”. This means that our topics cover more in-depth botanical knowledge and facilitate greater knowledge accumulation for those students who also choose biology in their final exams. Throughout the entire secondary school curriculum, teachers can use our programmes to effectively complement botany lessons. According to the curriculum, it is also expected that most of the learning objectives are covered by our programme in the sixth grade, where plants are the main topic of natural science lessons. In the sixth grade, most of the objectives are also covered by the “general tour” and the topic “plant organs”. In the latter, in connection with plant organs, students are also presented with the adaptation of plants to the environment, which to a certain extent examines the ecology of plants in a simpler way.

The analysis of visits and the organisation of guided tours over a ten-year period in the Ljubljana University Botanic Gardens clearly shows that the Botanic Gardens, with their educational programmes and collection of living plants, are an important aid for teaching natural science. With didactic aids (magnifying glasses, microscopes), trained teaching staff, live plant material and guided tours in a controlled natural environment, the Botanic Gardens can ensure and meet most learning objectives. Furthermore, the effectiveness of learning outdoors in nature is significantly higher than learning in the classroom [74–76]. Of course, we would like the gardens to become a learning environment for even more students.

5. Conclusions

Botanical gardens are known to play a significant role in public education, both directly and indirectly. At the University Botanic Gardens of Ljubljana, we have placed great emphasis on guided tours since 1986. Based on a review of the records of guided tours from 1986 to 2023, we observed a significant increase after 1995, when we introduced a new approach to guided tours. Previously, teaching in the garden was more static, but since 1995, we have guided our tours through the entire garden. Records from 2013 to 2023 showed that the highest attendance occurred in 2016, coinciding with the opening of the seed bank. A notable increase in visitors was also observed in 2011 when the tropical greenhouse opened. The largest proportion of guided tours is attended by primary school students, who represent more than half of all visitors. May and June are the most popular months for visits, as the gardens have most blooming plants during this time. September and October also have higher attendance, particularly among those interested in the diversity of trees. Visitors most often choose a general guided tour, which provides an overview of the garden’s history and highlights its most notable features. Even on general tours, we discuss topics such as biodiversity in Slovenia, invasive plants and the uses of various plant species. The second most popular theme is plant organs, largely because most of our visitors are sixth graders, who study this topic in their curriculum. In recent years, we have noticed an increasing interest in guided tours that include additional activities, such as planting plants and independent research in the garden. After 2019, there was a rise in tours focusing on pollinators and nectar-producing plants, reflecting the global surge in interest in pollinators. Our guided tours are designed to align with several educational objectives and serve as an important educational tool, particularly for sixth graders and high school students.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/jzbg5040052/s1>. Table S1: 1st grade; ENVIRONMENTAL EDUCATION; Table S2: 2nd grade; ENVIRONMENTAL EDUCATION; Table S3: 3rd grade; ENVIRONMENTAL EDUCATION; Table S4: 4th grade; NATURAL SCIENCE AND TECHNOLOGY; Table S5: 5th grade; NATURAL SCIENCE AND TECHNOLOGY; Table S6: 6th grade; NATURAL SCIENCE; Table S7:

7th grade; NATURAL SCIENCE; Table S8: 8th grade; BIOLOGY; Table S9: 9th grade; BIOLOGY; Table S10: High schools and faculties; BIOLOGY.

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