New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION

Interdisciplinary Educational Platform for Supporting Urban Biodiversity

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Abstract

Urban biodiversity, one of the essential conditions for human well-being, is becoming a recognized objective both within the academic community and among the general public. The support for urban biodiversity is provided by various ecological niches, ranging from green walls and roofs to urban gardens, squares, and street alignments.This paper proposes an interdisciplinary educational tool designed to provide information on the importance and support of biodiversity in urban spaces, while also advising the interested public on how to create ecological niches, considering urban constraints such as limited space, exposure, and permeability. As a learning tool, the platform has two primary educational objectives:1. to educate the general public and foster conservation-oriented attitudes, with the goal of biodiversity; 2. to educate students by involving them in populating the platform with data and participating in the interactions created through the platform. The effectiveness of this educational tool is evaluated based on the number of views and interactions, as well as at the urban level, through the increase in spaces that are conducive to biodiversity.

Keywords: *interdisciplinary education, educational platform, urban biodiversity*

1. Introduction

Urban biodiversity- although it refers to a reality that coincides with the form of social living, it is a relatively new concept. Over many centuries, the development of human society was ideologically separated from biodiversity, understood as the sum of wild flora and fauna. Humans aimed to create "ideal" living conditions in terms of absolute comfort, assuming an environment with ideal physical parameters, as healthy as possible, free of germs, and, in the same measure, easy to maintain, responding to an aesthetic that, most often, was largely detached from the world of nature. Until the end of the 20th century, human society had as its objective, albeit an unspoken one, the transformation of cities into "urban islands" with complete and safe facilities. In striving to achieve this goal, with the exception of a minority interested in fauna and flora, the majority of the population, ordinary residents as well as citizens involved in planning and decision-making processes, did not have concerns related to other living beings they might share their habitat with. It was believed that the place of fauna was in natural habitats, distinct from areas inhabited or used by humans. Regarding the presence of plant species, the prejudices were less defined, with some decorative plants being cultivated in gardens and parks.

The urban area has been densely developed, resulting in a negative transformation of the urban landscape, including the loss and fragmentation of ecosystems, which has led to a decline in the urban vegetation coverage and biodiversity and the extinction of species[1], [2].

The high degree of anthropization over large areas, the drastic reduction in the population numbers of many wild species, and the pressures generated by environmental activists have, among other things, led to the initiation of environmental policies, including biodiversity conservation. The strongest impetus for turning toward urban biodiversity comes from the degradation of the quality of urban life, despite efforts in architectural design and improvements in housing infrastructure. Despite technical progress and the use of innovative materials, issues such as chemical and noise pollution, difficulties in regulating building and city-wide temperatures, and waste management remain unresolved. Added to these are the declining quality of human life, in terms of mental health, driven by the artificial landscape, and not least, the decreasing number of species, the population sizes of many species, as well as the increasing risks of extinction. Today, it is known that green and blue spaces provide multiple ecosystem services. Forests, shrubs and grassesin urban areas provide a multitudine of ecosystemservices to city dwellers [4]. In addition, they improve the mental health of the residents and enhance the visual aesthetic senses of urban residents [5],[6]

In this social and natural environmental context, biodiversity studies have led to the idea that urbanized environments, in a broad sense, can constitute spaces for cohabitation and habitats not only for humans but also for a range of floral and faunal species, not just synanthropic ones. The conservation efforts regarding biodiversity are complemented by an increasing number of experiments and conclusions from environmental psychology, which suggest that human physical and mental health is directly correlated with urban biodiversity. Although environmental and human health specialists agree on the importance of urban biodiversity, moving from the theoretical level to large-scale implementation and improving urban biodiversity is a process bound for failure without the involvement of a critical segment of the city's population. This important segment of the population needs to be trained to have interest, knowledge, capabilities, and the will to act, as well as to integrate biodiversity into the value system. Educational levels can vary, from young people—students and pupils in the formal educational system—to the general public in an ongoing lifelong learning process. Educational success requires that cities generate a network of green spaces with the correct characteristics to support biodiversity.

2. Working Method

2.1 Case Study

Green spaces in several small and medium-sized cities in north-western Romania were analyzed from the following perspectives: a) Presence of green spaces, revealing the following deficiencies: pronounced fragmentation, lack of continuity/connectivity, presence of available and unused spaces; b) Quality of gardens and parks as support for biodiversity: areas of green spaces without structured vegetation, the predominant use of allochthonous plant species, and the use of plant species not aligned with biotope requirements; c) Intentions to properly design green spaces, coupled with a lack of knowledge.

City	Baia Mare	Satu Mare	Sighetu Marmației	Carei	Negrești Oaș	Târgu Lăpuș	Seini
Inhabitans of the city	108.759	91.520	32.793	18.957	11.867	11.744	8.987
City area	233,3 kmp	150,3 kmp	111kmp	1181,27 ha	130kmp	247,7	58,91

Tab. 1. The number of inhabitants and the area of the cities analyzed

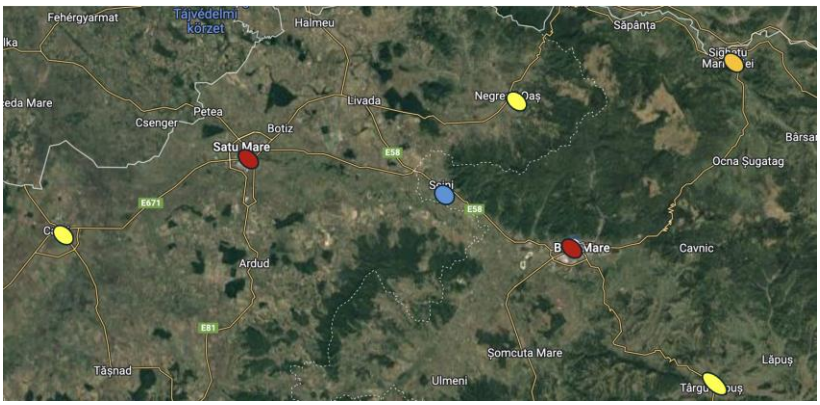

Fig. 1. The distribution of the cities analyzed in Northwestern Romania

2.2 Platform as a Learning Tool in Urban Biodiversity Education

In the process of designing the platform, the starting point was the analysis of the needs highlighted in the case study section. The platform was developed in such a way that users are sequentially guided through the analysis of all the peculiarities of abiotic factors. From a human development perspective, as an educational tool, the platform targets biology students who, in a volunteer activity framework, will manage the information made available to the general public, update biodiversity-related information

weekly, monitor forum questions, and provide appropriate answers. At the same time, they will post brief interventions regarding the importance and management of urban biodiversity. The second group of beneficiaries of the learning process is the general public interested in supporting biodiversity and the interventions that every person with at least one window sill can contribute to this process. In the medium to long term, by increasing the number of users, biodiversity should increase, as visible through annual monitoring carried out by students and pupils; on the other hand, a "culture of biodiversity" will be established among the city's citizens, reflected in daily practices and in local community policies.

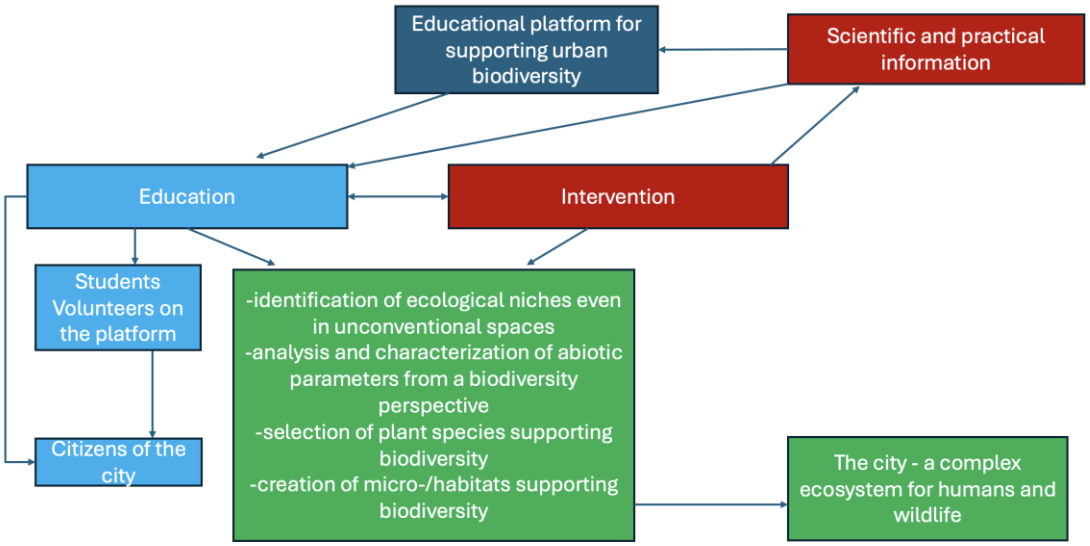

Fig. 2. Diagram of the educational platform for supporting urban biodiversity

2.3 The Need for Tools Aimed at Educating the General Public for Supporting Urban Biodiversity

Rapid urbanization creates multiple problems for urban biodiversity. Firstly, the reduction of natural green spaces is one of the greatest challenges, as infrastructure expansion and construction eliminate habitats for plants and animals. Additionally, urban ecosystems become fragmented due to roads, buildings, and other structures, which limits interaction and specific mobility, while the lack of public awareness about the importance of biodiversity in cities means that many ecological initiatives do not receive the necessary support. Furthermore, the use of ornamental or exotic plants, which do not support local fauna, often replaces beneficial native species. These problems highlight the need for educational tools to support informing and engaging citizens in protecting urban biodiversity.

Ecological education plays a crucial role in protecting urban biodiversity, as it transforms the way citizens perceive and interact with the surrounding environment. Informing citizens about the benefits of urban biodiversity is essential and includes emphasizing the role that biodiversity plays in reducing air and noise pollution by capturing suspended particles and emitting oxygen. Additionally, these areas help isolate sources of noise, thus reducing the effects of pollution. Another aspect to consider is combating the urban heat island effect, which can be achieved through the planting of trees that can lower temperatures in urban areas, providing shade, and protecting the soil and surfaces from direct sun exposure. Last but not least, creating a habitat for pollinators and other local species in the urban environment is essential for maintaining ecosystem balance.

The use of dedicated digital tools has the advantage of accessibility and popularity. The majority of the urban population has access to the internet and uses digital platforms. Creating an online tool allows for quick access to relevant and updated information, anytime and anywhere.

3. Target Groups

Volunteer students**:** This group can use the platform for education and practical initiatives. It will include team working sessions, guides for volunteering in public spaces, and ideas for community projects.

Garden owners**:** The ecological education of this group includes simple and effective methods, through the learning platform, to integrate biodiversity into their gardens.

Any citizen concerned with biodiversity, who has at least one windowsill, the minimum space that can be arranged to support biodiversity.

Each of these target groups plays a crucial role in the process of protecting biodiversity and urban ecological education. Collaboration between students, garden owners, and other interested parties can lead to the creation of a more sustainable, healthier, and nature-friendly urban environment, having a positive impact on the quality of life for all.

4. Physical and Biological Factors that Determine the Quality of the Types of Green Spaces for Which Selection and Training Will Be Done on the Platform

The quality of urban green spaces is influenced by a combination of physical and biological factors that affect not only the appearance and utility of these spaces, but also their effectiveness in supporting biodiversity and the health of the urban environment.

4.1 Physical Factors

Size of the available physical space – plays a significant role in the ability to support biodiversity. In general, larger spaces can support a greater diversity of species, more abundant resources (such as food and shelter), and a higher degree of habitat diversification. Thus, large parks play an important role in developing the urban microclimate, reducing the urban heat island effect, improving air quality, and providing refuges for species. However, even in small gardens and small urban green spaces, through careful planning, plant diversification, water conservation, and reducing the use of chemicals, habitats favorable to biodiversity can be created. Proper management of these spaces contributes to the conservation of urban ecosystems, improves the quality of life, and reduces the negative environmental impact.

Light and exposure to sunlight in the available space influences plant selection, species diversity, microclimate, and the overall health of the urban ecosystem. Proper management, based on an understanding of these factors, can maximize the benefits of green spaces for biodiversity and the local community. Areas with different light levels (direct sun, partial shade, full shade) can host a greater diversity of species, both plant and animal, with each level of light exposure creating unique opportunities. For example: a)well-sunny areas (direct sunlight exposure) are dominated by light-loving plants and species that rely on intense photosynthesis to grow quickly. Example: annual flowers, perennials that attract pollinators (e.g., sunflowers, lavender, thyme), shrubs or grasses that require intense light. The fauna associated with these areas includes pollinators (bees, butterflies, and wasps are attracted to flowers that produce nectar in such areas), reptiles and amphibians that warm themselves in the sun, such as lizards; b) Partially shaded areas (intermediate exposure) are spaces where light is filtered, usually by tree canopies or artificial structures. These areas provide a balance between light and cool conditions. Specific vegetation includes species that prefer moderate conditions, such as ferns, ornamental plants (e.g., hydrangea), and some edible herbs (e.g., parsley, mint). The fauna associated with these areas includes diverse pollinators (night butterflies, bees, and some beetle species can adapt to these conditions), small birds (shade patches offer shelter and a safe environment for birds that avoid direct sunlight), and amphibians (frogs and other species sensitive to dehydration prefer these areas where humidity is higher); c) Completely shaded areas (dense shade) are cooler habitats with minimal light, and house species that tolerate or even prefer the absence of direct sunlight. Specific vegetation includes shade-tolerant plants (ferns, geraniums, ivy, ground plants like hosta), fungi (in completely shaded and moist areas, fungi can grow, contributing to the ecosystem by decomposing organic matter). The fauna associated with these areas

includes nocturnal animals (bats, owls, and other species that avoid daylight), shade insects (ground beetles, spiders, and other insects prefer these conditions for coolness and shelter), and small animals (hedgehogs and other small mammals may use these habitats for refuge).

The diversity of habitats based on light levels plays a key role in maintaining biodiversity and ecological stability. Well-designed spaces that include areas with direct sunlight, partial shade, and dense shade create favorable conditions for a wide range of species, from pollinators to larger animals. Thus, strategic management of light and structures in urban green spaces can enhance their ecological value.

4.2 Biological Factors

Biological factors include plants, fauna, and microorganisms in the soil. Each of these contributes to the ecological balance, biodiversity, and functionality of green spaces. Integrating plants, fauna, and microorganisms into the design and management of green spaces is crucial for creating a functional ecosystem, with all elements being interdependent – plants provide food and shelter, fauna supports pollination and decomposition, and microorganisms maintain soil fertility. Well-designed green spaces also offer conditions for a wide variety of species. Diverse ecosystems are more resilient to stresses such as pollution, climate change, or the invasion of harmful species.

When selecting plants, it is important to choose species that are resistant to the specific conditions of the city, such as pollution, high temperatures, and compacted soils (e.g., pollution-resistant trees, drought-tolerant perennials). Another issue that must be considered is native vs. exotic plants. It is important to know that native plants are better adapted to local conditions, require less maintenance, and provide food for the region's fauna, while exotic plants can add diversity but sometimes become invasive, affecting local species.

Plant Diversity is another important point in the design of green spaces, taking into account their ecological functionality. Trees and shrubs provide shade, reduce temperature, and offer shelter for animals, while flowers attract pollinators and contribute to the aesthetics of the space.

Vegetation stratification by creating multiple layers (e.g., trees, shrubs, ground plants) increases habitat diversity and provides favorable conditions for different species. (Example: a layer of tall trees provides shade and shelter, while shrubs and flowers at ground level provide food for pollinators.)

Biological factors are fundamental to maintaining the quality and sustainability of urban green spaces. Planning that takes their interactions into account will result in healthier spaces that are more beneficial to communities.

5. Designing the Platform - Learning Tool for Urban Biodiversity Education

A website that hosts an online platform aimed at raising public awareness on the topic of urban biodiversity will include, in addition to detailed and varied thematic information, a series of components meant to ensure interactivity and offer an experience as engaging as possible. An interactive platform will be much more effective in disseminating information and getting closer to the target group(s). Thus, elements such as the discussion forum, the interactive guide designed to help the users of the site determine the plants intended for various types of spaces, lists of frequently asked questions, become necessary for the site to turn into an effective communication tool and, at the same time, a comprehensive database.

Such a platform dedicated to urban biodiversity could serve as a good tool for educating target groups in order to promote a greener and more sustainable urban environment. The site will focus on providing detailed information about plants suitable for cultivation in urban spaces, but also on developing interactive tools to help users make informed choices about selecting the right plants for various urban areas.

The website will have an informative section containing information on plants, educational resources, information on local events and initiatives that promote urban biodiversity. Visitors to the site will be able to learn about tree planting campaigns or urban gardening workshops in this online platform that encourages community involvement in activities that contribute to the creation of greener cities.

The plant information section will draw on a database of recommended plant species for different types of urban environments, providing information on the ecological benefits of plants, their specific environmental needs, their maintenance and their impact on biodiversity. Users could filter plants based on their environmental conditions, from plants for shade, to those that are drought-resistant or can handle heavy traffic.

The central interactive element of the site is a guide in the form of a quiz, which helps users choose the right plants for their spaces. Through a detailed questionnaire, users can answer a series of questions about facts such as the size of the available space, the type of the layout desired (horizontal or vertical), the specific location (indoor or outdoor), the light conditions (sun exposure and the amount of light available). Depending on the answers provided, the tool will suggest a list of plants that best suit the environmental requirements, ensuring a personalized and easy-to-implement selection.This interactive digital application is intended to optimize the plants selection process, adapted to the specific conditions of the user's environment. It works based on selecting personalized recommendations from a database, considering several determining factors for plant growth and development.

The process begins with a structured questionnaire, in which the user is invited to fill in a series of questions designed to define the characteristics of the space intended for planting. The first questions refer to the *size* of this space, an essential parameter that influences both the choice of plant type and the density of planting. Thus, the user will be able to specify whether he has an extended space (e.g. garden, terrace) or a smaller one (e.g. balcony, window sill), each of these scenarios imposing different recommendations in terms of the typology of suggested plants.

The next step focuses on determining the *spatial layout*, which may involve *horizontal* or *vertical* planting options. This differentiation is important because plants that grow horizontally usually have different space requirements than those that are more suitable for a vertical arrangement, such as hanging plants or those that lend themselves to the use of supporting structures, such as planters or grills.

Another factor in the selection process is the *location* of the space, taking into consideration whether it is an *indoor* environment (e.g. home, office) or an *exterior* one (e.g. yard, garden). This distinction allows identifying plants that are adapted to specific climate and microclimate conditions, such as temperature, humidity and protection from extreme weather conditions.

The next aspect in selecting the suitable plants is *light exposure* and *the amount of light* available. These criteria are meant to establish which plant species will thrive in the environment. The quiz will ask the user to assess the degree of exposure to natural light (direct sun, semi-shade or total shade) and the intensity of available light, factors that influence the physiological processes of plants, such as photosynthesis and vegetative development.

Based on the answers provided by the user, the application will use this data to generate a list of plants that best meet the conditions provided by the user. We consider that this tool would be a valuable aid in the plant selection process, providing users with appropriate recommendations based on their needs, thus contributing to an informed choice appropriate to the specific context of each user.

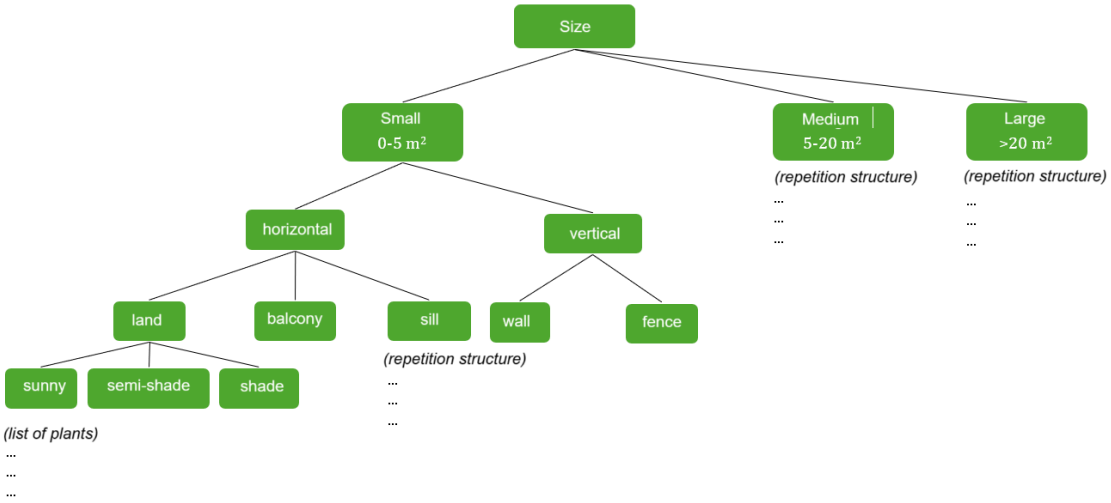

Fig. 3. Sectiunile sit-ului

In order to support interaction and knowledge exchange, we consider it appropriate to implement a discussion forum. Here, users could ask questions, share experiences, and discuss various aspects of urban gardening, leading to the coagulation of a community. The forums will be moderated by teachers, researchers or experienced users, who will answer questions and provide advice.

The design of the site is a modern one, which adapts for display on the most common devices, so that users can access the information and interactive tools from mobile phones or tablets. As the user base grows, the design of a newsletter containing information about events and news about urban biodiversity will also be considered.

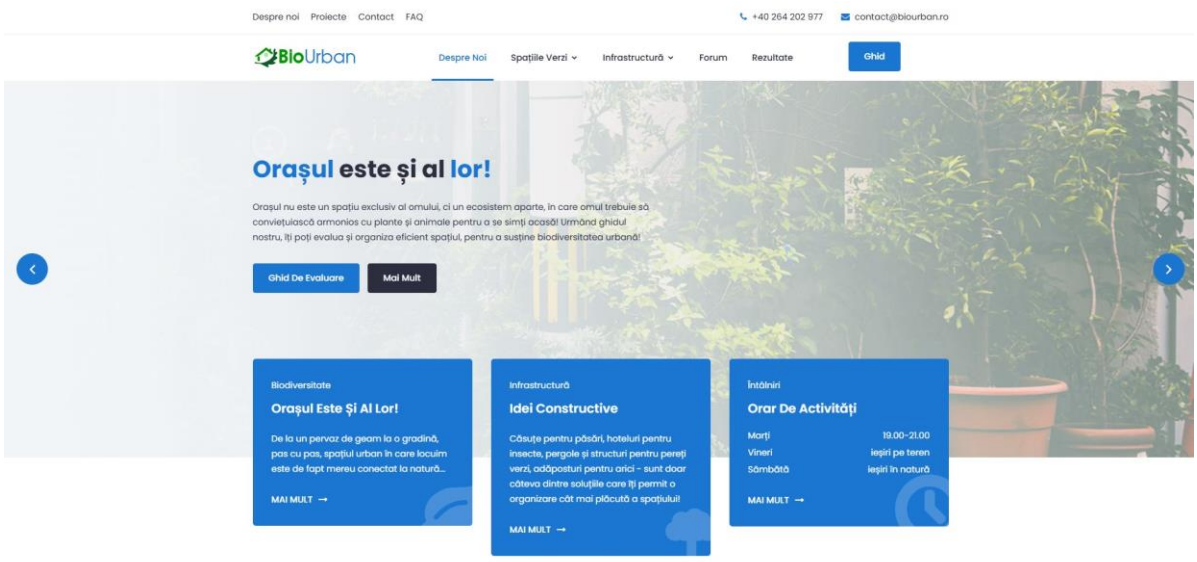

Fig. 4. Site desktop

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